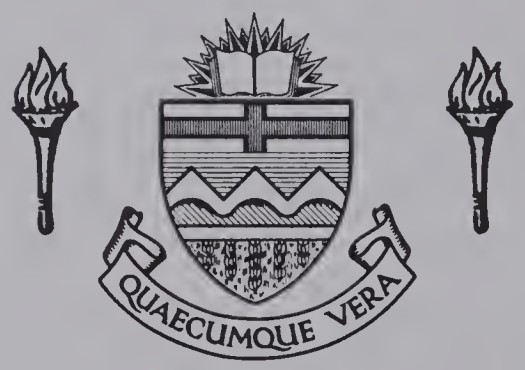

THE UNIVERSITY OF ALBERTA

ECONOMIC CHARACTERISTICS OF THE YUKON MINING INDUSTRY

by

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A THESIS

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "Economic Characteristics of the Yukon Mining Industry" submitted by W. Douglas Daniels in partial fulfilment of the requirements for the degree of Master of Arts.

ABSTRACT

This study is primarily an economic examination of the structural characteristics of the Yukon mining industry. A detailed cost breakdown for the exploration, development and operational phases of the industry was attempted. This study presented this information for the three major sub-sectors of the Yukon industry at present, asbestos, open-pit and underground mining operations.

Information on the costs as well as the proportions of input usage in the Yukon mining industry is very limited and estimations had to be used in many cases.

The development of large scale, open-pit mines in the latter half of the last decade has significantly changed the nature of the Yukon industry. The degree of capital-intensity of the mining industry has increased, resulting in a corresponding increase in the skill level of the mining personnel.

The Yukon economy has only a limited degree of interdependence between sectors and existing linkages between the Yukon mining industry and the rest of the economy are very small. The relative impact on the regional economy per dollar of mining expenditures is declining as leakages have become more significant. This can be mainly attributed to the increasing degree of capital-intensity and foreign ownership of the mining industry.

ACKNOWLEDGEMENTS

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CHAPTER ONE

INTRODUCTION

Nature and Scope of the Study

This thesis involves an economic analysis of the nature, structure, and impact of the mining industry in the Yukon economy. A brief survey of some key economic features of the Yukon economy is undertaken and the significance and nature of the mining industry is outlined. The chief research contribution of this study focuses on an economic examination of the structural characteristics of the Yukon mineral industry. In particular, a detailed cost breakdown for the exploration, development and operational phases of the major subsectors of the industry is attempted. Utilizing this cost breakdown, a preliminary economic assessment of the impact of the mining industry on other sectors and other regions is attempted. Finally, the results of the study are summarized and some policy and future research recommendations are outlined. Some questions for further study are considered.

The economy of the Yukon has expanded considerably in the last few years and the value of annual mineral production, the leading sector, has increased from 13.2 million dollars in 1960 to 79.6 million in 1970. Monetary per capita income is now the highest of any region in the country and considerable expansion in the infrastructure has occurred during the last decade. Transportation and communications have reduced the element of isolation and the territorial government is assuming more of the substance and trappings of a provincial government.

However, the Yukon is still an underdeveloped region relative to its potential, and the southern regions of Canada. The economic base remains very narrow and the federal government provides substantial public assistance indirectly, by grants to the territorial government and directly, in terms of infrastructure and economic incentives. The role of the federal government will probably continue to be extensive for some years and public policy will be a crucial factor in determining the rate of development.

Although the structure of the economy is becoming diversified, the mining industry will continue as the leading sector for the foreseeable future. Indeed, a major study has recently predicted that the relative importance of the mining industry in the Yukon will increase to 1985. In many respects, the Yukon region resembles a typical developing country with a "one-crop" economy and the necessity for planning and active participation by the public sector in creating or initiating economic development at an acceptable rate.

Given the nature of the Yukon economy, it becomes imperative to consider the position of the mining industry and its potential. Planning, to be able to predict both quantitative and qualitative changes in the economy, must be cognizant of the constraints and prospects of the mining sector. This requires quantitative information about the structure of the industry and its impact on the economy.

Objectives

The general objective of this thesis is to conduct an economic analysis of the nature, structure and impact of the mining industry

in the Yukon economy.

The first specific objective of the proposed research is to outline the principal economic features of the Yukon economy. The second objective is to briefly examine the supply and demand conditions facing the Yukon mining industry and to consider the development and changing nature of the industry.

The third objective is an attempt to quantify certain structural characteristics of the Yukon mining industry. This objective involves a cost breakdown of the preproduction and operating phases of three key sub-sectors of the industry.

The fourth objective is to analyze the linkages with other sectors of the local economy and to determine expenditure leakages to Canada and the rest of the world.

The final objective is to summarize the major conclusions of the study and provide recommendations for public policy in the Yukon.

Rationale

There are a number of factors which make the Yukon mining industry attractive for analysis. Several studies have been completed recently which outline the mineral resources of the Yukon and suggest a strong potential for growth of the mining industry. However, these studies have not developed a detailed breakdown of the structural characteristics of the Yukon mining industry which are essential for different kinds of planning models and impact studies. There appears to be a strong need for planning by both the public and private sectors.

This is implied for the private sector by the capital-intensive

nature of the industry and the major preproduction expenditures necessary to develop a mine. Reliance on planning can be expected to increase even more in the future with the trend to mining lower grade deposits on a large scale rather than exploiting small deposits of high grade ore over a short time horizon.

The limited infrastructural facilities in the Yukon create a need for extensive public investment as the mining industry expands. Certain crucial policy decisions will have to be made within the next decade, particularly related to the development of transportation facilities. Public investment must be based on priorities determined by the impact of investment in different regions and different sectors. A proper assessment of the impact of public investment requires estimates of indirect effects, determined by linkages, as well as the direct effects. Other policy questions which are now being considered relate to the kinds of mining regulations necessary to preserve the fragile ecology of the north and the incidence of taxation since Yukon royalties have not been adjusted since 1926.

It is not obvious that extensive public investment to create a favourable climate for mining developments in the Yukon is a priority at any given time. The mining industry is characterized by weak existing linkage effects, both forwards and backwards. There is a minimal amount of processing of mineral ores produced in the Yukon and the lack of diversity in its economy suggests a great deal of leakage. The immobile or permanent labour force is not large and hence, comparability with development expenditure by the federal government in another region such as the Atlantic provinces with high rates of unemployment

is doubtful. The permanent labour force, containing a large number of native people, has not played much of a role in mining employment and the increasing skill content in many mining positions may continue to limit their participation. In this connection, the potential and recent growth of the tourist industry which is more labour-intensive and creates more lower-skilled positions suggests the possibility of emphasizing this industry as an alternate growth sector. The long run viability of developing the Yukon with employment and income largely dependent on exploitation of a non-renewable resource raises other questions.

Public policies developed for the Yukon mining industry may also have some applicability on the development of the mining sectors of other northern regions. The superior facilities and more responsible political system in the Yukon relative to the Northwest Territories suggests that the rate and method of development may be emulated there as well. The northern zones of many of the provinces have similar economic structures and the encouragement of mining as a leading sector will probably be influenced by the development approach used in the Yukon. The status of the Yukon as a political region means that data is more likely to be available than in political sub-regions such as northern British Columbia or northern Ontario.

Tools of Analysis

The most acceptable and useful tool for use in impact studies and determination of linkages is the input-output table developed by W. Leontieff. Input-output tables allow the multiplier effect from an

additional dollar of final sales by any industry to be calculated. A tentative transactions table for the Yukon has been developed by the authors of the Carr Report[1] based on their estimates of interindustry purchases in 1966.

Unfortunately, this table has only limited usefulness for this study. Major changes in the structure of the Yukon mining industry have occurred since the table was developed. The only significant mining activities in 1966 were the operations of United Keno Hill Mines Limited and the Yukon Consolidated Gold Corporation, which ceased operations shortly afterwards.

Secondly, the mining industry is very hetrogeneous by nature and combining all sub-sectors of the industry produces input ratios which are valid only for that time or that particular combination of mines.

The approach to be utilized in this study is a disaggregation of the Yukon mining industry into three more homogeneous classes: open-pit, underground and asbestos mining operations. In this way, it is possible to predict the level and kind of inputs, not only to take account of expansion of the industry but also to adjust to changes in the kind of mining operation.

Another major objective of this study is to quantify the linkages with industries in other regions of the country and leakages

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[1] Carr, D.W. and Associates Limited, A Model Simulation of the Yukon Economy. Vol. III: The Yukon Economy: Its Potential for Growth and Continuity. A Report prepared for the Department of Indian Affairs and Northern Development and the Government of the Yukon Territory. Ottawa: Queen's Printer, 1968, p. 72.

outside the Canadian economy. The Carr input-output table cannot be used for this purpose for it is restricted to showing interindustry purchases within the Yukon region. Even within this region, the input-output table allows only analysis of interindustry purchases and separates only wages and salaries from total primary inputs. In an immature economy like the Yukon, leakages from primary input expenditures become very important. Consideration will be given to the quantitative significance of leakages from primary inputs in this study.

Limitations

Time and data constraints have made it advisable to place some fairly restrictive limitations on the scope of this study. The mining industry is defined to exclude fuel minerals, due to the special nature of this industry, whereby demand, volume of production and reserve requirements create a bulky and discontinuous change in development. However, the petroleum industry may become important as the exploration for reserves in the northern Yukon might be used as input for the proposed pipeline down the Mackenzie River Valley from Prudhoe Bay in Alaska. Most of the non-metallic minerals, except for asbestos, are likely to depend mainly on development of the Yukon economy for they tend to have a low-unit value. Principal attention will thus be focused on the metallic minerals, except for asbestos and coal. Some consideration will be given to technical innovations but the focus will be on the present structure and economies to be achieved with development of facilities already existing elsewhere. It is not proposed to

dwell at length on the potential resource base or to develop projections of future demand conditions for several studies have considered this already.

Data

As in most studies concerned with northern Canada, the paucity of information represents a constraint on the scope and validity of the study. Published data by government agencies is limited by the relative insignificance of the northern region and the confidentiality requirements of the Statistics Act. Hence greater reliance must be placed on personal communications and publications by private businesses and institutions. It is likely that this shortage of official statistics will decline as the economy of the Yukon expands. Anticipating this development, estimates were used, but reliance on the use of proxies or generations from the specific were avoided, whenever possible, so that the data presented can be directly utilized in future research.

The primary sources used were the eight volumes published as the Carr Report on the Yukon, Yukon government publications, mining industry reports by Dominion Bureau of Statistics, mining journals and newspapers. Some information was also obtained by direct communication with officials of the mining companies.

Format

The format of this thesis is based on the objectives outlined so that Chapter II outlines some of the important economic character-

istics of the Yukon economy. Chapter III deals with supply and demand conditions and the development of the industry. Chapter IV attempts a cost breakdown of major sub-sectors while Chapter V provides quantitative estimates of leakages by source. Chapter VI is a summarizing chapter in which results of the study and recommendations for policy and future research are given.

CHAPTER TWO

SOME CHARACTERISTICS OF THE YUKON ECONOMY

Physical Features

The Yukon Territory is located in the northwestern part of Canada with the Northwest Territories along the eastern boundary, British Columbia to the south, Alaska on the west and a small outlet to the Beaufort Sea in the north. It is the smaller of the two northern political divisions with a land area of 207,076 square miles compared to 1,304,903 square miles in the Northwest Territories.

The topography of this region is hilly to mountainous and reasonably level land is found primarily in the river valleys. Geologically, it represents the northward extension of the Cordilleras and their flanks, and thus forms part of the two most important mineral-bearing regions in North America, the Cordillera and Precambrian Shield.

The mountain ranges provide formidable barriers to transportation with the Coast Range and St. Elias Mountains obstructing access to the Pacific Ocean through the Alaskan Panhandle, and the Selwyn and Richardson Ranges impeding access to the Mackenzie River Basin. Of the major river systems, the Yukon River is the most important and drains about 85% of the land area. In contrast with the rivers in the Northwest Territories, which are the major form of transportation, the rivers in the Yukon represent barriers to movement. Precipitation is quite low and averages only 20 inches a year.

The climate of the Yukon has an important effect on the cost structure of the economy. Altitude, latitude, physical barriers and

TABLE NO. 1

LONG-TERM CLIMATIC DATA, SELECTED STATIONS

	Height above mean sea level	Precipitation average annual	Average frost-free period	Days with mean temperature above 42° F	Average July temperature	June-August heating factor (below 65° F)	October-April heating factor (below 65° F)
	(feet)	(inches)	(days)		(degrees F)	(day-degrees)	
Dawson, Y.T.	1,062	12.67	90	136	59.8	748	13,104
Watson Lake, Y.T.	2,248	16.98	101	144	59.1	812	11,775
Whitehorse, Y.T.	2,289	10.67	78	143	56.2	901	10,408
Haines Junction, Y.T.	2,030	10.94	53	122	53.8	1,219	11,419
Yellowknife, N.W.T.	682	8.45	113	125	60.9	797	13,437
Prince George, B.C.	2,218	22.16	68	166	59.6	766	8,077
Edmonton, Alta.	2,219	17.63	100	n.a.	62.9	476	8,981
Calgary, Alta.	3,540	17.47	91	155	62.4	550	8,100
Saskatoon (A), Sask.	1,690	14.40	111	n.a.	66.4	350	9,752
Churchill, Man.	115	15.01	63	95	54.7	1,410	13,484
Winnipeg, Man.	786	19.72	110	176	68.4	259	9,696
London, Ont.	912	38.24	137	205	69.6	150	6,750
Knob Lake, Que.	1,681	27.55	70	103	55.1	1,223	12,040

Source: Carr, D.W. and Associates Ltd., Vol. I. op. cit. p. 110.

Route, and the Canol pipeline from Norman Wells. The active involvement of the defense industry also began to decline, with the passing of any military threat to the Northwest, until its virtual disappearance in 1968.

The history of great spurts in economic activity characteristic of the past, seems to be part of the formula for future development. A similar boom period resulting from the opening of the Cassiar Asbestos mine at Clinton Creek and Anvil's mine at Faro in the latter part of the sixties tends to confirm this. Consideration will be given later to the costs of discontinuous development and prospects for a trend to less discrete changes.

A second legacy from previous boom periods, especially the defense created boom of the forties, is the infrastructural development in transportation and communications. The White Pass and Yukon Railway, a product of the Gold Rush provided a rail outlet to the ocean and world markets for minerals. The Alaska Highway provided the first land link with the southern regions of Canada and created a new interest in developing the Yukon.

Another major legacy left from the past but difficult to quantify is the attitudes of residents about northern development and their image of the North as a permanent home. Except for the indigenous population and a small permanent nucleus of immigrants from the south, the North has been considered as a place to "make a grubstake," a temporary place of residence. This attitude also prevailed in the operations of the construction and mining companies and this lack of a sense of permanence continues to retard planning and investment in

permanent facilities. An obvious economic manifestation of the importance of this attitudinal input is the comparative shortage of cultural amenities and the low proportion of the population in the private service industries with high rates of turnover in the labour force reflecting the lack of these facilities. It remains to be seen whether the development of an expanded mining industry with a long life expectancy will create a sense of permanence and destroy the "grab and git" image of the North.[1]

Population and Labour Force

The volatile nature of the economy in the Yukon is reflected in population fluctuations over time. Three distinct phases can be recognized, the great influx into the territory during the Klondike Gold Rush, an almost equally rapid emigration until 1921, and a period of stagnation until 1941 when wartime developments initiated a fairly rapid population increase. Table 2 shows changes in the population of the Yukon in each census period.

Although changes in population and other indicators imply a high degree of mobility in response to economic changes, this is not true of all segments of the labour force. Skilled personnel, not usually available within the Yukon, are recruited in southern Canada and move out readily when demand for their services fall. However, the unskilled labour force contains many Yukon residents, both white

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[1] There are a number of books which describe the colourful history of the Yukon and analyze the process of historical development. See, for example, Rea, K.J., The Political Economy of the North, (Toronto: The University of Toronto Press, 1968)

TABLE NO. 2

CENSUS AND ESTIMATES OF INDIAN POPULATION

YUKON TERRITORY, SELECTED YEARS

Year	Indian Population	Total Yukon Population	Indian Population as per cent of Total Yukon Population
	(number)		(per cent)
1901	3,322	27,219	12.2
1911	1,489	8,512	17.5
1921	1,390	4,157	33.4
1931	1,543	4,230	36.5
1941	1,508	4,914	30.7
1951	1,533	9,096	16.9
1961	2,167	14,628	14.8
1965	2,292	14,382	15.9

Source: Carr, D.W. and Associates Ltd., Analysis of Statistics and Statistical Needs of the Yukon Territory. Vol. II: The Yukon Economy: Its Potential for Growth and Continuity. (Ottawa: Queen's Printer, 1968), p. 51.

and Indian, who are quite immobile and form the hard core of unemployed when labour demand declines.

Table 3 shows significant differences in the proportions of the population in the experienced labour force and the number of wage earners. The rate of natural increase in the Yukon, which is 50 per cent greater than the Canadian average, accounts for the slightly lower than average proportion of the Yukon population in the labour force. On the other hand, the ratio in the experienced labour force is substantially above the Canadian average because of the disproportionately large number of males in the Yukon (See Table 4).

The participation of the Indian population in the labour force is still very limited with only 33 per cent of the 1,253 Indians in the potential labour force qualifying in the experienced labour force category. The comparable figure for the non-Indian population is 71 per cent. The experienced Indian labour force is also predominantly employed in the less skilled positions, such as "labourers, not otherwise specified," "service and recreational workers," and "fishermen, trappers, and hunters." Less than 50 of the 416 Indians in the 1961 labour force were listed as "craftsmen, production process and related workers" and only seven were included in the technical, managerial and professional fields.[1]

The non-native population of the Yukon can thus be summarized as largely urban, very mobile in response to economic changes, and

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[1] Department of Indian Affairs and Northern Development, The Yukon Today, (Ottawa: 1968), p. 44.

TABLE NO. 3

COMPARISONS OF LABOUR FORCE, 1961

Classification	Total Yukon Population	Yukon Indian Population	British Columbia	Canada
Population 15 years of age and over	9,343	1,253	1,119,030	12,046,325
Per cent of Total Population	64%	62%	69%	66%
Experienced Labour Force	6,242	416	577,646	6,471,850
Per cent of Population 15 years of age and over	67%	33%	52%	54%
Wage Earners	5,386	339	474,316	5,162,712
Per cent of Experienced Labour Force	86%	81%	82%	80%

Source: Department of Indian Affairs and Northern Development, The Yukon Today, (Ottawa: Queen's Printer, 1968), Tables 6 & 7.

TABLE NO. 4

POPULATION BY SEX, YUKON TERRITORY AND CANADA, SELECTED YEARS

	Yukon				Canada
Year	Male	Female	Total	Males per 100 Females	Males per 100 Females
1901	23,084	4,135	27,219	558	105
1911	6,508	2,004	8,512	325	113
1921	2,819	1,338	4,157	211	106
1931	2,825	1,405	4,230	201	107
1941	3,153	1,761	4,914	179	105
1951	5,457	3,639	9,096	150	102
1956	6,924	5,266	12,190	131	103
1961	8,178	6,450	14,628	127	102
1966	7,805	6,577	14,382	119	101
1969	8,100	6,900	15,000	117	101

Sources: Carr, D.W. and Associates Ltd., Vol. II. op. cit. p. 48. and Dominion Bureau of Statistics, Vital Statistics Preliminary Annual Report, Catalogue No. 84-201. (Ottawa: 1969)

exhibiting a high male/female ratio, the typical characteristics of a frontier region. The Indian population exhibits more of the characteristics of a newly industrializing society; a population pyramid reflecting a high rate of natural increase and a small experienced labour force restricted to less skill-intensive activities.

Value of Production

Table 5 gives a breakdown of census value-added[1] for the Yukon and Northwest Territories combined, as the Dominion Bureau of Statistics does not publish this data separately for the Yukon. Unfortunately, there are some significant differences in the economies of the two regions and it is difficult to distinguish between them accurately. In 1966, the gross value of production of the leading sector, mining in each territory was 12 million in the Yukon and 114.3 million in the Northwest Territories. Mining is not as diversified in the Northwest Territories for the Pine Point mine produced over 95 million dollars or 83 per cent of total output. Most of the commercial fishing takes place in the Northwest Territories while 60 per cent of the gross value of forestry is produced by the Yukon.

With only estimates of gross value of production for the

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[1]Census value-added differs from the standard definition of the net value of production. Net value is a measure of "value-added" by an industry to the total value of production and is determined by deducting from the gross value of output, the costs of all purchased inputs from other businesses. Census value-added deducts only the cost of materials from gross value of production (exclusive of excise and other sales taxes).

TABLE NO. 5

CENSUS VALUE ADDED[1] FOR GOODS-PRODUCING INDUSTRIES,
CANADA AND SELECTED REGIONS, 1966

	Yukon and Northwest Territories[2]		British Columbia		Alberta		Canada	
	$'000	p.c.	$'000	p.c.	$'000	p.c.	$'000	p.c.
Agriculture	----	----	134,385	4.7	636,235	24.7	3,223,433	11.1
Forestry	15	----	305,039	10.7	7,211	0.3	673,033	2.3
Fisheries	792	1.2	60,693	2.1	844	----	176,088	0.6
Trapping	911	1.4	777	----	1,776	0.1	13,741	0.1
Mining	56,780	87.8	214,372	7.6	772,079	29.9	2,609,603	9.0
Electric power	4,711	7.3	117,926	4.2	74,231	2.9	1,132,370	3.9
Manufactures	1,489	2.3	1,347,065	47.3	527,197	20.4	16,351,740	56.3
Construction	[3]	[3]	666,324	23.4	558,172	21.7	4,843,683	16.7
Totals	64,698	100.0	2,846,581	100.0	2,577,746	100.0	29,023,690	100.0

Source: Dominion Bureau of Statistics, Canada Yearbook 1969, (Ottawa: Queen's Printer, 1969)

Notes: [1]Census value-added is equal to the gross value of production (exclusive of excise and other sales taxes) minus the cost of materials.

[2]Data is not compiled separately for the Yukon.

[3]The construction industry in the territories is included with British Columbia.

Yukon,[1] it is not possible to show total value by adding, or the relative share of each industry as the use of primary inputs may differ substantially between sectors. Analysis of annual rates of growth would be even more misleading for they imply some degree of comparability and continuity over time, whereas the Yukon is characterized by a very narrow regional base and large discrete changes in output. It may be worthwhile, however, to briefly examine the structure of the economy for insights into the nature and relative importance of the different sectors and their relationships.

Primary Industries[2]

The primary industries defined to include mining, agriculture, forestry, fishing, hunting, and trapping have had quite different rates of development during the last decade, but, mainly owing to the development of major mines in the latter half, they have increased in importance. Using the 1961 Census information, and Territorial Workmen's Compensation Reports, the Carr Report estimated employment in the primary industries as 18.7 per cent in 1961 and 21.6 per cent

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[1] Another reason for hesitation in compiling output values is the number of activities which are intangible or not amenable to classification in quantitative terms. These activities include exploration for natural resources, tourism, transportation and especially the public sector which plays a substantial role in the economy. There are certain sectors such as fishing, hunting, and trapping where 'income in kind' is important but this is always difficult to quantify. Estimates of the average commercial gross values of output for the different sectors in the period 1961-1966 are given in Carr, D.W. and Associates Ltd., Vol. II. op. cit. p. 120.

[2] Most of the information for the discussion in this section is taken from Carr, D.W. and Associates Ltd., Vol. I. op. cit. pp. 120-283.

in 1966. Using just the Workmen's Compensation Reports,[1] we get estimates of employment in the primary industries of 28.8, 23.9 and 22.7 per cent for 1961, 1966 and 1969 respectively. The comparable figures for employment in the primary industries in Canada were 14.2 per cent in 1961 and 10.1 per cent in 1968, indicating that employment in the Yukon is very dependent on basic activities and does not have a wide range of supporting industries.

The only major primary industry is mining but as it will be examined more thoroughly in the next chapter, only a brief discussion of its importance is given here. The rapid rise in the gross value of output has not been reflected in proportional increases in employment, due to the change in the kind of minerals produced and the development of more capital-intensive mining operations. The value of mineral sales was fairly stable from 1960 to 1967, averaging slightly more than 15 million dollars annually. The commencement of production of the Cassiar Asbestos and Anvil mines provided the main impetus for a dramatic increase to 79.6 million by 1970. The Carr Report estimated that the value of mineral production would rise to 50 million in 1970 and 85 million by 1985. It seems likely, however, that the value of mineral sales will exceed 100 million by 1975, and that the mining

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[1] Yukon Territory Workmen's Compensation Administration Annual Report, Alberta Workmen's Compensation Board, (Edmonton: 1970). This report excludes a number of categories because these occupations are not covered by Workmen's Compensation or are not representative of the Standard Industrial Classification. These categories are excluded: government, hunting, fishing, trapping, and agriculture. Due to the large number of government employees and those in the other excluded services, the estimates given are likely to overestimate the relative importance of the primary industries.

industry will continue to be not only the leading sector, but almost the only export sector on which the rest of the economy will depend.

The only other primary industry which offers prospects for growth is the forestry sector. Although the value of production averaged less than 700,000 dollars a year between 1962-63 and 1966-67, it has grown rapidly since then. The volume of production has more than doubled by 1970 and as a result of recent contracts with four companies, output will reach a minimum of 40 million board feet annually by 1973, four times the volume produced in 1970.[1] The rate of growth will be closely tied to the growth of the Yukon region for it is very unlikely that any product but a pulp mill could compete in outside markets.

The industry has been characterized to date by spasmodic growth and improper planning and organization of resources. It does not appear to be very capital-intensive and the value of gross output per worker was 6,400 dollars in 1961 and 15,800 dollars in 1966.

The other primary industries are very small, inefficient, and likely to decline in the future except for their potential as inputs for the tourist industry. The harsh physical environment and high costs of production have reduced the number of farms to nine in 1966, only two of them being commercial in the sense of marketing more than 2,500 dollars a year. Trapping and fishing together accounted for only 120 thousand dollars of gross output in 1966. The value of gross

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[1] Estimated from: Government of the Yukon Territory, Yukon Territory Annual Report, (Whitehorse: 1970), p.47 and Department of Indian Affairs and Northern Development, Canada/North of 60: Newsletter, January-March, 1970.

output per capita had fallen to about 250 dollars in 1967. The growth of the tourist industry is likely to present the only important viable economic use of the animal and fish resources in the region. Nearly three-quarters of the license revenue for hunting, of 37,500 dollars in 1967 and 57,800 dollars in 1969 was from non-resident fees.

It appears, therefore, that the primary industrial sector will be dominated even more in the future by mining, and forestry to a lesser degree. The economy will continue to respond quickly to mining developments and stability in the mining sector is more essential than in a more multifunctional economy.

Of the secondary occupations, only construction is important. It is heavily dependent on new mining operations and is, therefore, even more volatile than the Canadian construction industry. With the trend to exploitation of large-scale low grade ore deposits, the output of the construction industry in the Yukon will fluctuate even more dramatically in the future. The value of construction activity had an average fluctuation of 25 per cent between 1962 and 1966 whereas the value of mining construction increased from 0.3 million dollars in 1964 to 11 million in 1967. The building boom died down fairly quickly once the Faro townsite was completed. One fairly predictable result of this feature of the industry is the small number of construction companies operating in the Yukon. The large contracts are won by firms who may be registered in the Yukon but are located in Edmonton or Vancouver. The importance of this is discussed in Chapter IV when linkages are examined.

The manufacturing and processing industries are very small and

had an average annual output of only 600,000 dollars between 1961 and 1966. Even with an increase in the labour force and a larger number of dependents, it is not likely that manufacturing of consumer goods will assume any importance. The only major prospect for developing the manufacturing sector would be a lead-zinc smelter which will be considered by Anvil Mining Corporation before 1975. It would likely be comparable to the proposed smelter at Pine Point in the Northwest Territories which would require an investment of 40 to 50 million dollars and generate output valued at 25 million a year.[1]

Services

The service industries are defined here to include transportation and other utilities, quaternary occupations (professional, business, community and personal services), construction and the public services. The service industries employed 74 per cent of the labour force in 1966 with the primary and manufacturing industries providing the remainder. This represents a very high proportion in the non-primary activities as the Canadian ratio was only 64.9 per cent in the same year. However, the public sector as the most important employer in the Yukon accounts for most of this and there is a substantial inflow of money from the federal government in the form of wages and salaries. Quaternary occupations which "provide services

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[1] Armstrong, G.T. and Freyman, A.J., Cost-Benefit Analysis of a Lead-Zinc Smelter in the Northwest Territories, (Ottawa: Economic Staff Group, Development Branch, Department of Indian Affairs and Northern Development, 1969).

to tertiary occupations and to other quaternary occupations"[1] are limited and the public sector has been responsible for much of their development to date.

Tourism

The second most important source of income from exports is the sale of goods and services to the tourist industry. The importance of this industry is growing and its value was estimated at almost 7 million dollars in 1967 and 10 million in 1968. The tourist industry is characterized by a heavy proportion of expenditure directed to the service sectors with a high labour content and by a very short season in the Yukon.

Transportation and Other Utilities

The basic developmental services of power, transportation, and communications will play a key role in determining the rate of growth and viability of the other sectors. The transportation network in the Yukon is centred on Whitehorse as a result of its historical importance as the "confluence of the southern limit of river navigation and the northward limit of rail from tidewater .... The result has been a consistent, if forced, insularity. Canada has been placed 'outside.' The Yukon, in habit of thought, channels of commerce, administrative posture, and deployment of development is still oriented toward

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[1] Kahn, H., "World Futures." Science Journal 3: 120-125. October, 1967. p. 24.

tidewater through Whitehorse."[1]

The road network within the Yukon is still in its developmental stages but it is being expanded under a 10 year 100 million dollar federal programme for the Yukon and Northwest Territories. The federal government has been prepared to help finance access roads to any mine-site so that there is little problem for the mining industry in removing ore concentrate by road to the railhead. The quality of road services is, however, a serious impediment to the growth of the tourist industry for the gravel roads and the dust problems make travelling very uncomfortable for the tourist.

The White Pass and Yukon Railway serves as the sole rail and oil pipeline links into the Yukon and offers the only year-round access to tidewater. It has expanded its operations to develop the largest fleet of semi-trailer trucks in the territory, a bus fleet, shipping services between Vancouver and Skagway, and a truck transport service between Edmonton, Dawson Creek and Whitehorse. This imposes a transportation monopoly on the Yukon with the attendant problems of monopoly pricing.

The transportation structure appears adequate at present but the development of new mines will hopefully expand rail services in the Yukon and lower costs. Surveys are presently being carried out by the White Pass and Yukon Railway into the feasibility of extending the railhead north towards Carmacks while studies have also been carried out on the possibility of extending either the Pacific Great Eastern or the

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[1] Carr, D.W. and Associates Ltd., Vol. I. op. cit. p. 273.

Canadian National Railways north from British Columbia.

The electrical power industry provides fairly extensive coverage of the Yukon but the sources are scattered and capable of supplying only fairly high-cost power. However, if projections[1] of demand for 330 megawatts in 1980, compared to consumption of 30.5 megawatts in 1968, are fairly accurate, the opportunity to develop large scale capacity with corresponding lower costs is approaching. One interesting possible source of power would be a thermal plant using the coal reserves at Carmacks. Although reserves are not known and the seams are relatively thin, coal mining requires a small initial investment and is fairly labour-intensive.

Summary

This description of the sectors of the Yukon economy, while not clarifying the relationships between sectors or their exact relative importances, does give the general framework of the economy. The mining industry is definitely the leading industry with only tourism among the other industries, likely to play any significant role as an export industry. The supporting industries are not likely to show a corresponding rate of growth as leakages from the Yukon economy will reduce the multiplier effect that we would normally expect. The capital-intensive nature of the mining industry and the higher costs of small-scale supporting industries will be a major factor in diminishing the growth of secondary and service industries. The population has not

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[1] C.B.A. Engineering, Yukon Power Survey, (Vancouver: 1968) p. 20.

benefited equally from development of the mining industry as the permanent labour force has a very low participation rate.

CHAPTER THREE

DEVELOPMENT AND NATURE OF THE MINING INDUSTRY

The Canadian and Yukon Mineral Industries

The mining industry in Canada has maintained its relative share of the value of total production[1] during the last quarter century in contrast to the more densely populated industrial countries. The mining industry in the United States has declined to 1.3 per cent of the value of total production, only half of its share in 1949, whereas the Canadian industry has remained at about 4 per cent. The growth rate of the Canadian industry has averaged 11.4 per cent annually between 1947 and 1957 and 5.7 per cent in the decade 1957-1967, compared to an average annual growth rate of 4.7 per cent for the economy over the whole period.

The Yukon's share of Canadian mineral production has been fairly insignificant in recent years and has averaged less than two per cent of Canadian production in the post-war period. It reached a peak of 1.1 per cent relative to the Canadian industry in 1954 and then declined until 1968. The commencement of operation of new mines in the latter part of the last decade resulted in a rapid increase in gross output to 79.6 million dollars in 1970, when it represented 1.3 per cent of the Canadian industry.

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[1] It is very difficult to measure accurately the economic impact of any given industry. The net value of production used by Dominion Bureau of Statistics removes only raw material, fuel and electricity inputs from gross value. Depreciation, business services, and other purchases should also be removed for estimates of value-added.

The limited number of minerals produced in the Yukon has meant, however, that the Yukon is a more important producer in some of the sub-sectors of the mineral industry. Mineral resources are classified into metal mines, nonmetal mines and mineral fuels. Metal mines and mineral fuels each account for about 45 per cent of Canadian production while nonmetal mines produce 8 per cent and structural materials 3 per cent. In the Yukon, silver, lead, zinc, copper and asbestos make up more than 90 per cent of the value of the region's output. Of these, the only nonmetallic is asbestos which represents 7 per cent of Canadian asbestos production.

Comparing the Yukon's share of the output of different minerals in 1970, we can see the importance of the Yukon in certain minerals. Lead and zinc production represents 17.9 and 6.4 per cent of the Canadian totals respectively. Asbestos, as already mentioned, represents 7 per cent and silver which once contributed more than 20 per cent of Canadian output represented slightly less than 10 per cent in 1970.

The kinds of minerals produced have an important bearing on the regional economy because of the different proportions in which inputs are used. As an example, labour income represents only 36.7 per cent of total factor costs for asbestos mines and 53.2 per cent of total factor costs for other nonmetals.

It is misleading to examine only the value of production of the mining sector since inclusion of the mineral processing industries, which are normally classified in the manufacturing sector, nearly doubles the value of mining to the economy. The Yukon is significantly

less valuable in this sense, for nearly all mineral products are exported as ore concentrates. Only a very limited amount of lead-zinc concentrates have been shipped to the Cominco smelter at Trail, British Columbia.

If the study on the feasibility of a lead-zinc smelter which Anvil Mining Corporation agreed to undertake by 1975 is favourable, then the situation could change. However, a similar study commissioned by the federal government for the Pine Point operation suggested a very low profit level for a northern smelter. Based on a smelter life of 25 years, estimates of rates of return varied from 2.4 to 5.4 per cent for different lead and zinc prices and inputs.[1] Anvil Mining Corporation may be reluctant to develop a smelter for a number of reasons. It is generally conceded that corporate returns are optimized by the export of concentrates as the rate of return is usually lower for higher stages of processing. Another major barrier to the development of a Yukon smelting industry is the escalation of tariffs as mineral products are exported at higher stages of fabrication. The most important market for Yukon mineral exports is Japan which is actively expanding its own smelting facilities. More than 98 per cent of Japanese imports of Canadian mineral products which are important to the Yukon are in a raw or concentrate form.

The benefit to the Canadian economy of an important export industry is tempered by the large proportion which is exported with

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[1] Armstrong, G.T. and Freyman, A.J., op. cit. p. 12.

very little processing. Crude minerals as a per cent of total exports were 16.4 per cent in 1970 and combined with fabricated mineral products accounted for 31.6 per cent of export earnings. If the assumption is made that Canada must try to develop more than a primary product export base, then development of the Yukon industry is less attractive.[1]

As the mining industry is capital-intensive, the input requirements from other industries provides important benefits. Mineral ores and concentrates account for 47 per cent of all revenue railcar loadings in Canada and 20 per cent of the domestic output of the basic chemical industry is used in mining. The impact of the Yukon mining industry on other sectors of the regional and national economies is examined in Chapter V.

While the mining industry in the Yukon may have only minor importance for the whole Canadian industry, it is by far the most important sector in the Yukon. Table 5 shows the relative importance of the different sectors of the Yukon and Northwest Territories economy, and the Canadian and British Columbia economies. Although there are differences in the economies of the Yukon and Northwest Territories as pointed out in the previous chapter, it is clear that the mining industry is so important in the Yukon that it is not inaccurate to classify the Yukon economy as a staple economy based on mineral extraction.

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[1]The latest statement on the benefits of emphasizing labour-intensive activities such as secondary manufacturing was made by Dr. Solandt in the 1970-71 Annual Report of the Science Council of Canada, (Ottawa: Information Canada, 1971), p. 37.

Development

The mining industry in the Yukon has a fairly long but unstable history. The value of production ranged from 22.5 million dollars in 1900 to 1 million in 1924, to 2.7 million in 1928, 5 million in 1938, and from 0.9 million in 1944 to 15 million in 1954. Between 1955 and 1967 the value of output fluctuated between 11 and 15 million dollars. Then production from the New Imperial, Cassiar, and Anvil mines raised output more than fivefold to 79.6 million dollars in 1970.

Gold represented nearly all of the Yukon's output until 1922, when silver production from the Mayo area became important. These two minerals represented more than 80 per cent of output until 1948 when United Keno Hill Mines commenced operations and began to produce lead and zinc on a large scale. However, it was the silver contnet in the ore which made it possible to mill the lead and zinc.

Production of gold and silver continued to represent more than half of the value of mineral production until 1968. By then the major gold producer, Yukon Consolidated Gold Corporation had shut down, and the only silver mine, United Keno Hill Mines was forced to curtail operations. Production of new minerals increased as copper and asbestos deposits were developed. In 1970, the value of gold and silver production represented only 11 per cent of the Yukon mining industry's output.

The last decade represents more than a change in the quantity and kind of minerals produced. The nature of the industry has changed.

Gold and silver reserves could be exploited in an immature

economy with high costs because of their high unit value. Capital investment is not large relative to other kinds of mines and both the Yukon Consolidated Gold Corporation and United Keno Hill Mines have operated on a short-run basis, despite the length of operation of both of these mines. The operation of mines in response to short-term demand or limited deposits is still a feature of the industry. Canada Tungsten Mining Company on the Yukon-Northwest Territories border shut down in 1963, re-opened in 1964, closed when the mill burnt in 1966 and re-opened again in 1967. Arctic Gold and Silver Mining and Mount Nansen Silver Mines both closed within a year, while New Imperial Mines operated for only four years and then ceased production for one year. In contrast, the development of lead-zinc and asbestos deposits require careful planning and reasonable assurance of a long life-expectancy in order to justify large preproduction expenditures for minerals with low market prices per unit.

Although the limited number of operating mines in the Yukon at any one time makes comparisons of minimum economical grades of ore difficult to determine, there seems to be a trend to exploitation of large scale lower grade deposits. The only mine in continuous operation for more than 10 years is United Keno Hill Mines and the metal content in the ore in place is about 120 dollars a ton at current prices. Canada Tungsten which began production near the Yukon in 1961 has ore valued at 37 dollars a ton. The major mines established since 1965 have metal content in the ore valued at 34 dollars a ton at Anvil Mines, 15.50 dollars at New Imperial and 14 dollars at Cassiar's mine.

This is a very important trend for the practise of high grading,

or mining of only the highest grades of ores in a deposit, in order to increase the per unit value and compensate for higher operating and transporation costs, has resulted in a loss of potential mineral resources. There are obvious long-run disadvantages to the Canadian economy as a result of this practise, as once the higher grades of ore are removed, it is unlikely that the remaining ore could be profitably exploited in the future. Of all the parameters affecting supply, price changes have the greatest effect on the rate of return and the optimal cut-off grade. If the predictions of substantial price increases given in the next section are realized, the 'cut-off' or minimum grade of ore exploited is likely to decrease and high grading will become less serious. One of the major mines in the Yukon, United Keno Hill Mines Limited, has been able to avoid extensive use of high grading for it has a variety of ores available at different mine sites and has been able to select ratios of base metals and silver depending on the market prices, but other mines are based on high grading.

The grade of ore required in a mineral deposit will continue to be higher than the Canadian average in order to compensate for higher input costs but changes in demand and methods of production appear to allow more scope for a broadening of the industry's base by production of a wider range of minerals.

The development of mines with a long time horizon makes investment in more capital-intensive facilities and infrastructure more attractive. Capital will be substituted for labour which is a costly input in real and monetary terms in the North. Northern labour receives higher wages and fringe benefits and has a lower level of productivity

because of higher rates of turnover than in the more populated regions.

The transportation element becomes more crucial as large quantities of minerals with low unit values are exported. At the same time, companies are developing mines at increasingly distant locations from Whitehorse. United Keno Hill Mines is located 280 miles from railhead at Whitehorse and was the most northern mine in the Yukon until the development of the asbestos deposits at Clinton Creek which are 400 miles from Whitehorse. Canada Tungsten Mining Corporation, although located in the Northwest Territories, is oriented to the Yukon by a road connecting it to the Watson Lake-Ross River Road. Developed in 1959-1962, the company has to truck the ore about 200 miles to Watson Lake where it is transferred to long-distance road transport to Fort St. John, British Columbia. From there, transport is by railway piggy-back to Vancouver. While not as far from railhead as the Canada Tungsten mine, the Cassiar Asbestos mine is significant for it represents the first large scale, low unit value mineral deposit to be exploited at such a distance from rail and sea transport.

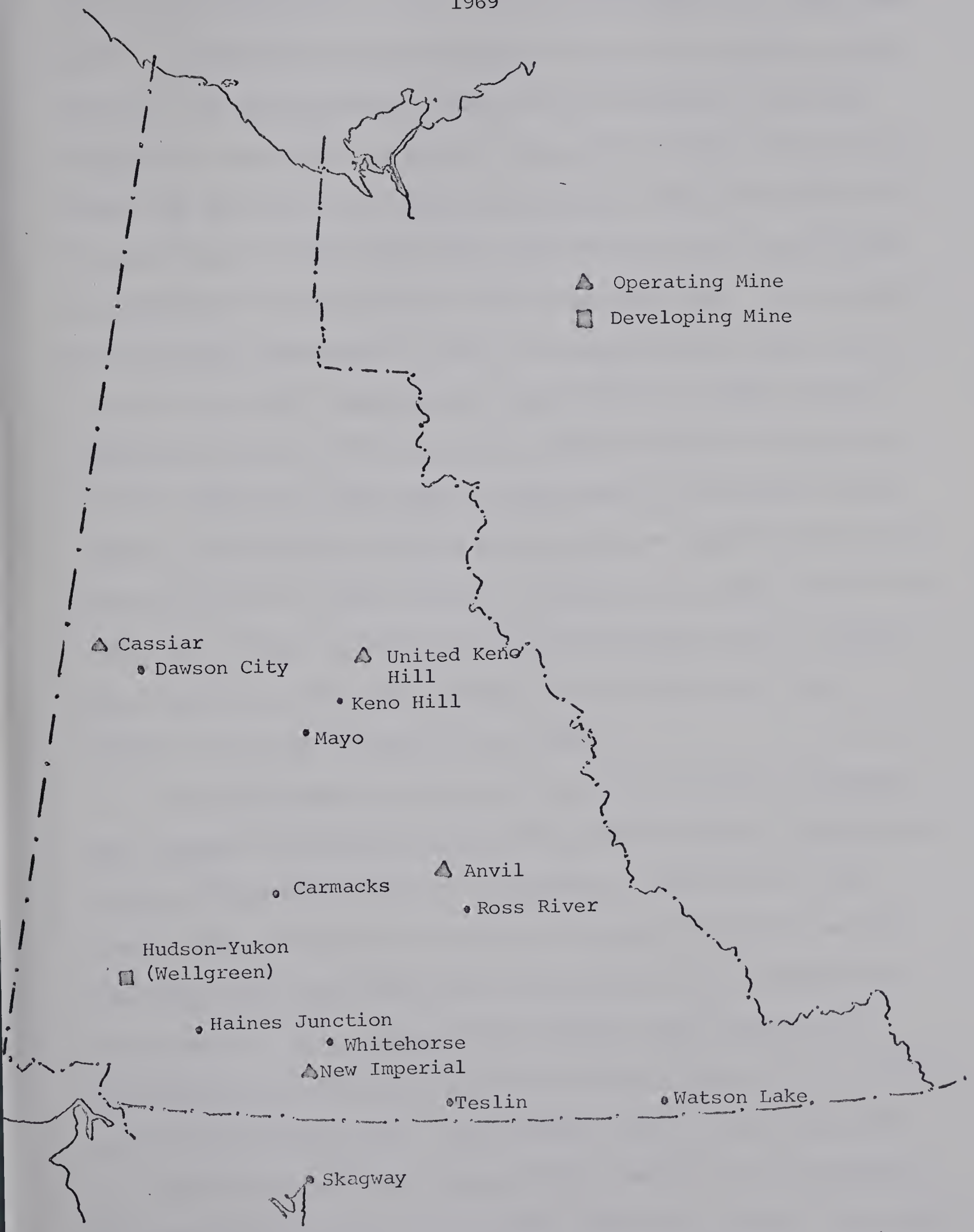
The mining industry in the Yukon is reasonably stable and the development of large-scale operations should contribute a further stabilizing influence. United Keno Hill Mines, a subsidiary of Falconbridge, is able to use the parent companies marketing facilities. Anvil and New Imperial mines were developed on the basis of long term contracts with Sumitomo Metal Mining Company of Japan. Cassiar Asbestos is producing a product which has had very strong prices and the market is likely to continue to be favourable.

Another feature of the Yukon industry is the enclave nature of

FIGURE I

LOCATION OF MAJOR YUKON TERRITORY MINES

1969



Source: Mining Association of British Columbia, (Vancouver: 1970)

much of the development to date. The only multifunctional population centre in the Yukon is Whitehorse which serves as the capital, communications and transportation centre for the Territory. The mining industry is responsible for much of the growth of this centre but even there, the territorial and federal governments employ about 1400 while the two largest private businesses, the White Pass and Yukon Railway and New Imperial Mines together employ only about 500. It is possible that continued development on some of the major mineral belts such as the Anvil-Ross River lead-zinc belt may result in a number of mines opening up which will utilize common services external to the mines. This has happened to some extent already with the Territorial Supply Company Limited which is jointly owned by Cassiar Asbestos Corporation and United Keno Hill Mines Limited. It serves as a supply and service agency with offices at North Vancouver and Whitehorse while a wholly-owned subsidiary, Yukon Coal Company Limited supplies coal from Carmacks for heating purposes at both mines.

The development of large-scale open-pit mines has introduced other changes in the Yukon industry for open-pit mining in the North is not very different from open-pit operations in other parts of the country. Open-pit mines are usually more capital-intensive and thus reduce the labour input and their corresponding service expenditures. United Keno Hill Mines, Venus Mines, Tantalus Butte and the new Wellgreen mine are underground while New Imperial Mines will be opening an underground mine in 1972. The open-pit mines at Faro and Clinton Creek operated by Anvil and Cassiar mining companies are new developments which will be exploiting minerals with lower per unit values than

the underground mines.

Another distinguishing feature of the Yukon mining industry has been the degree of horizontal and vertical integration. The immaturity of the Yukon economy in terms of supporting services and infrastructure has forced the mining companies to provide many of these facilities themselves. The necessity of providing fuel, power, transportation and social facilities has made the Yukon mining industries more capital-intensive than their counterparts in other regions, although the mining industry is generally located in areas of the country with limited supporting facilities. Horizontal integration of the industry at any location was forced on the companies for the same factors that induced companies to supply a large proportion of their own inputs. Heavy capital investment in facilities which offered considerable economies of scale forced the smaller operators to rely on or merge with the largest company. This trend has been evident in both the Klondike gold and Mayo silver-lead-zinc districts with the Yukon Consolidated Gold Corporation and United Keno Hill Mines respectively dominating production after the initial period of exploitation.

Demand and Supply Potential

There have been a number of excellent reports on the mineral

resources of the Yukon[1] and the following section will give only a brief outline of the mineral endowment of the area.

A distinction must be made between the total mineral endowment, which refers to higher than normal concentrations of minerals in an area, and economic mineral resources which include only above average concentrations of minerals in the earth's crust down to minable depths and which could be mined under favourable conditions. This means that we must decide on cut-off grades, the amount of minerals present per ton of ore, based on the minimum likely mineral content capable of being profitably mined. Thus, potentially minable resources are only a subset of the total endowment and this subset will change in response to changes in the parameters of supply and demand.

The Yukon is located in the Cordilleran region, an area richly endowed with minerals. Although there are a variety of mineral deposits throughout the territory, only a certain number of them are likely to be important and these minerals are often concentrated in specific regions or belts.

The major minerals currently being produced are lead, zinc, gold, silver, and asbestos, with nickel production scheduled to start in September, 1971. Other minerals of economic significance are

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[1] Two good sources for information on the Yukon's mineral resources are: Magyar, W.B. and Monture, G.C., Reference Study on Minerals, Vol. V. Background study for Carr, D.W. and Associates Ltd., The Yukon Economy: Its Potential for Growth and Continuity, (Ottawa: Queen's Printer, 1968) and Findlay, D.C., The Mineral Industry of Yukon Territory and Southwestern District of Mackenzie. Papers 67-40, 68-68, 69-55. Geological Survey of Canada, (Ottawa: Department of Energy, Mines and Resources, 1967-1969)

tungsten, mercury, molybdenum, iron and coal.

Projections of mineral endowments in a region involve estimates of the unknown and hence are subject to varying degrees of reliability. The study recently conducted by the Department of Energy, Mines and Resources[1] on the Canadian Northwest combined probability theory and traditional geologic analysis and averaged the opinions of 20 geologists on the likely mineral endowment of the area. Defining the Canadian Northwest as the Yukon and British Columbia north of the 53° latitude, the region was divided into cells and estimates of likely mineral resources were classified by tonnage into marginal, average and high grade categories.

Examining the eleven minerals mentioned previously, and excluding marginal and sub-marginal resources, the results suggested mineral resources, valued at 1968 prices were about 150,000 dollars per square mile or a total of approximately 31 billion dollars for the Yukon. This can be compared with an alternate estimate of 220,000 dollars per square mile suggested by Harris[2] in another study, based on extrapolation from a control area in another region of the Cordilleran range.

Known reserves and the value of production to date for the Canadian Northwest are estimated at 6 to 12 billion dollars, or 25,000 dollars per square mile. Comparable figures for just the Yukon

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[1]Barry, G.S. and Freyman, A.J., Mineral Endowment of the Canadian Northwest, Mineral Information Bulletin MR 105. (Ottawa: Mineral Resources Branch, Department of Energy, Mines and Resources, 1970)

[2]Harris, D.P., "A Probability Model of Mineral Wealth" Transactions, A.I.M.E., Society of Mining Engineers, June 1966. pp. 199-216.

can be conservatively estimated as 4 billion dollars or 20,000 dollars per square mile, based on cummulative production of 636 million dollars to date and estimates[1] of the value of known reserves of 3,498 million dollars.

Lead-zinc deposits appear to be one of the most important ores in the Yukon and combining estimates of unproven reserves of 80 million tons with the proven reserves of Anvil Mining Corporation, lead-zinc ore is likely to exceed 150 million tons in the Anvil-Ross region alone. Asbestos reserves are also substantial with estimates of more than 2 billion dollars in the Stikine River-Clinton Creek region. Other minerals with a good potential are gold, silver, copper, nickel, iron and tungsten.

If the Yukon appears to be amply endowed with mineral resources, projections of mineral demand are equally optimistic. "The markets closest to the North are growing rapidly and ... the range of natural resources known to exist in the North appear to be in precisely those materials where some relative scarcity or significant profit potential is expected before the end of the century."[2]

The Yukon is likely to be most competitive in the Pacific Rim countries, specifically Japan and the United States. Japanese imports of minerals have been increasing at an annual rate of 16 per cent in

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[1] The prices used and known reserves are given in Table 15.

[2] Wilson, G.W., "World Market Potential for Northern Resources." Symposium: Arctic and Middle North Transportation, (Slater, B.F. ed.) (Washington: The Arctic Institute of North America, 1969), p. 36.

the last decade and plans to greatly increase smelting and refining facilities suggest this trend will continue. Estimates of cummulative demand by the end of the century in the United States, exceed reserves of lead by 1000 per cent, reserves of zinc by 300 per cent, copper reserves by 50 per cent, and iron reserves by 40 per cent.[1]

The current market for non-ferrous metals appears most promising. Lead-zinc deposits appear to be the most likely new sources of production in the near future in the Yukon and supply and demand appear to be roughly in balance with each growing about 4 per cent a year.[2] Demand for asbestos is increasing at an annual rate of 5 per cent and shortages are expected by 1975.[3] Copper and nickel also face very favourable demand conditions. Silver has been in very short supply and high grade deposits could be profitably exploited.

Of the major minerals present in the Yukon, only iron ore and gold reserves are unlikely to be seriously considered for sometime. Iron ore must be produced at very low costs and the current abundance of large iron deposits in more accessible regions make any development of the Yukon's tremendous reserves unprofitable for some decades. The

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[1] Landsberg, H.H. et al, Resources in America's Future. (Baltimore: 1963), quoted in Wilson, G.W. op. cit. p. 36.

[2] Craig, D.B., and Kelly, A.J., "A Critical Review of Northern Mineral Potential," Canadian Mining Journal, Vol. 91, April 1970. pp. 76-98.

[3] Pye, E.G., "Current Activities and Trends in Exploration in Ontario," Canadian Mining Journal, Vol. 91, April 1970. pp. 112-118.

outlook is similarly bleak for gold mining as long as the price of gold remains fixed.

It would appear then that neither the mineral base nor the demand for mineral resources will present major obstacles to development of the mining industry. The major constraints will be the ability of the Yukon mining industry to improve its competitive position as relative scarcity in the more accessible regions increases and its ability to control costs as new ore bodies are developed in more isolated areas of the Yukon. This means that the development of new mines must be based on high grade deposits sufficient to overcome higher input costs. The purpose of the next section will be to examine the position of the Yukon mining industry and develop estimates of the higher costs involved. Unfortunately, the number of studies, which project rates of growth in demand and prices for different minerals, are not duplicated for supply conditions. Information about the cost structure and trends in production costs of the mining industry is not readily available except for general estimates or isolated fragments of specific data.

CHAPTER FOUR

A COST BREAKDOWN OF THE YUKON MINING INDUSTRY

Introduction

The purpose of this chapter is to attempt to provide a cost breakdown of each of the three main phases of mining activity: exploration, development and operation of a mine. A further disaggregation is attempted for the preproduction and operating phases of three distinct kinds of mining operations: asbestos, open-pit and underground mines. Exploration costs are often combined with development costs to give total costs of the preproduction phase. As exploration costs are not significantly different for discovery of different minerals, the distinctions between preproduction costs for asbestos, open-pit and underground mines can be attributed largely to differences in development costs.

The rationale for disaggregating the mining industry into product sectors is based on the assumption that input costs in the different sectors and their impact on the local economy vary to such a degree that a composite index of input ratios has little validity for projection purposes. Of course, an aggregation of input cost ratios is useful for judging the impact of the mining industry on the economy at any particular time or as long as the relative importance of the different sectors remains the same. However, the comparative ease with which small underground mines may open or close operations and the rate of technological change implies that aggregate input usage will continue to change. A rough composite index of the input

structure of the operating phases of the mining companies is attempted only at the end of the chapter in order to allow a comparison with the value of aggregate input ratios for the Yukon industry in 1961.

A study of the Yukon mining industry in 1969, prepared by Price, Waterhouse and Co.[1] provides a cost breakdown by inputs for all phases of the mining industry combined. These figures have not been used except for the examination of linkages and leakages in Chapter Five since it makes little sense to combine preproduction and operating costs. An example of the confusion this causes is the study's comparison of labour income as a proportion of sales revenue for the years 1965-1969. As the Cassiar and Anvil mines were being prepared for production in this period, extensive use of labour in the pre-production phase raised the ratio of the value of labour/output to 70 per cent in 1966. As the preproduction phases of these two companies ended, the ratio dropped drastically to 34 per cent in 1969. Obviously, this kind of ratio provides few clues to the share of labour in input expenditures for operating mines.

The ratios of input usage between the preproduction and operating phases of mining activity are separated not only because of the different proportions in which inputs are used between these two phases but also because their impact on the regional and national economies are different. The use of imported construction labour, machinery and equipment suggests that the effect of the preproduction

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[1] See Price, Waterhouse and Co., The Yukon Mining Industry in 1969 (mimeo) undated.

phase on the regional economy may be very limited.

It should be pointed out that preproduction costs are accounted for in the operating costs of mining operations in the form of returns to capital such as profits and interest on loan capital. Thus the relative importance of the preproduction phase can be determined from operating cost data but the impact of preproduction expenditures is concentrated over a different time span before the mine opens and operating costs are measured.

The next two sections examine exploration and development activities in the Yukon. Exploration costs are presented for all known programmes in the Yukon and also as a proportion of total pre-production expenditures of new mines. The final section examines the operating phase of Yukon mines and outlines a rationale for dividing the Yukon industry into three mineral sectors. Based on the three mining companies analyzed, the proportions in which inputs were used in 1969 are compared to the ratio of inputs in 1961. Finally the reasons for the change in the relative importance of the primary inputs are considered.

The Preproduction Stage: Exploration

The preproduction stage of a mine can be divided into an exploration and a mine development phase. The relative importance of these phases have been increasing for the Yukon and the Canadian mining industry as a whole. The exploratory activities of the mining industry are concentrated on the more remote regions of Canadian mineral zones and hence the Yukon is a major beneficiary.

The development of more remote and lower grade deposits has increased the relative proportion spent on the development phase. At the same time, development activities are spread over a longer period. This increases the impact of this phase on the regional economy and necessitates an increase in life expectancy of mining operations.

The exploration phase presents difficulties in effectively costing or attributing exploration expenditures to specific mines. If the company has an operating mine in the Yukon, it may charge all exploration expenses to that mine. This is the practise of United Keno Hill Mines. While there is no necessary correlation between exploratory activity and discovery of economic deposits, there is usually an increase in known reserves and mining development as exploration expenditure increases. However, there can be a great deal of variation in the level of exploration costs that must be borne by one mine.

Once economic ore deposits are found, the costs incurred in proving the grade and quantity of reserves may eventually be costed to the potential value of development of a new mine, rather than to current mining output. Table 6 shows various expenditure levels and estimates to 1968. Exploration expenditures represented an average of about one third of the value of the region's mining output between 1961 and 1968 based on Carr estimates. This average has fallen as the development of new mines in the latter part of the sixties increased production but it still represents more than twice the Canadian ratio.

Although there is considerable optimism about the long-run prospects of the Yukon mineral industry, this has not resulted in a consistent program of expenditure. Combined expenditures between 1961

TABLE NO. 6

COSTS OF PROSPECTING, CANADA AND THE YUKON, 1955 - 1968

	Metal Mining Companies[1]		Mineral Exploration and Development[2]	Oil and Gas Exploration[2]
	Non Producing and Producing (000's)	Producing Only[1]	million dollars	million dollars
1955	1,609			
1957	784			
1959	272			
1961	473	155	1.0	1.6
1962	1,638	333	2.0	3.2
1963	1,103	664	3.0	8.2
1964		700	4.0	8.3
1965		1,047	5.0	5.3
1966			6.0	1.9
1967			5.0	N.A.
1968			5.0	N.A.

Sources: Dominion Bureau of Statistics, General Review of the Mineral Industries, Catalogue No. 26-201, 1962, 1964 and 1965. and Carr, D.W. and Associates Ltd. Vol. I, op. cit. p. 124.

Notes: [1]The Dominion Bureau of Statistics has published data for producing,and producing and non-producing metal mines combined as shown. This represents a very conservative estimate with the Carr Report estimating expenditures more than twice as large.

[2]These two columns represent the Carr Report's estimates of total exploration and development expenditure.

and 1966 had an average annual fluctuation of 25 per cent. Figure II on the next page shows an equivalent instability in the number of claims staked.

The exploratory phase is difficult to break down into specific inputs but the trend to increasing capitalization is evident. The number of individual prospectors is declining and exploration programmes by large companies are undertaken on a more capital-intensive scale today, using aircraft and other equipment. The cost of exploration activities in the Yukon are substantially above those in more developed regions because of the shorter working season and the necessity for aerial transportation and development of field camps. The Anvil project involved 1 million dollars in exploration to locate the orebody and 4 million dollars on further testing before the decision to develop the mine was undertaken. A similar development at the Texas Gulf deposit near Timmins, Ontario cost only about half this amount.[1]

The most reliable indicator of these higher costs is the labour cost per foot of drilling in the Yukon and Canadian industries.[2] Table 7 indicates that the average labour cost in the Yukon has increased from 89 per cent more than the Canadian average in 1952 to 165 per cent in 1968.

A cost breakdown by input category is not possible because of

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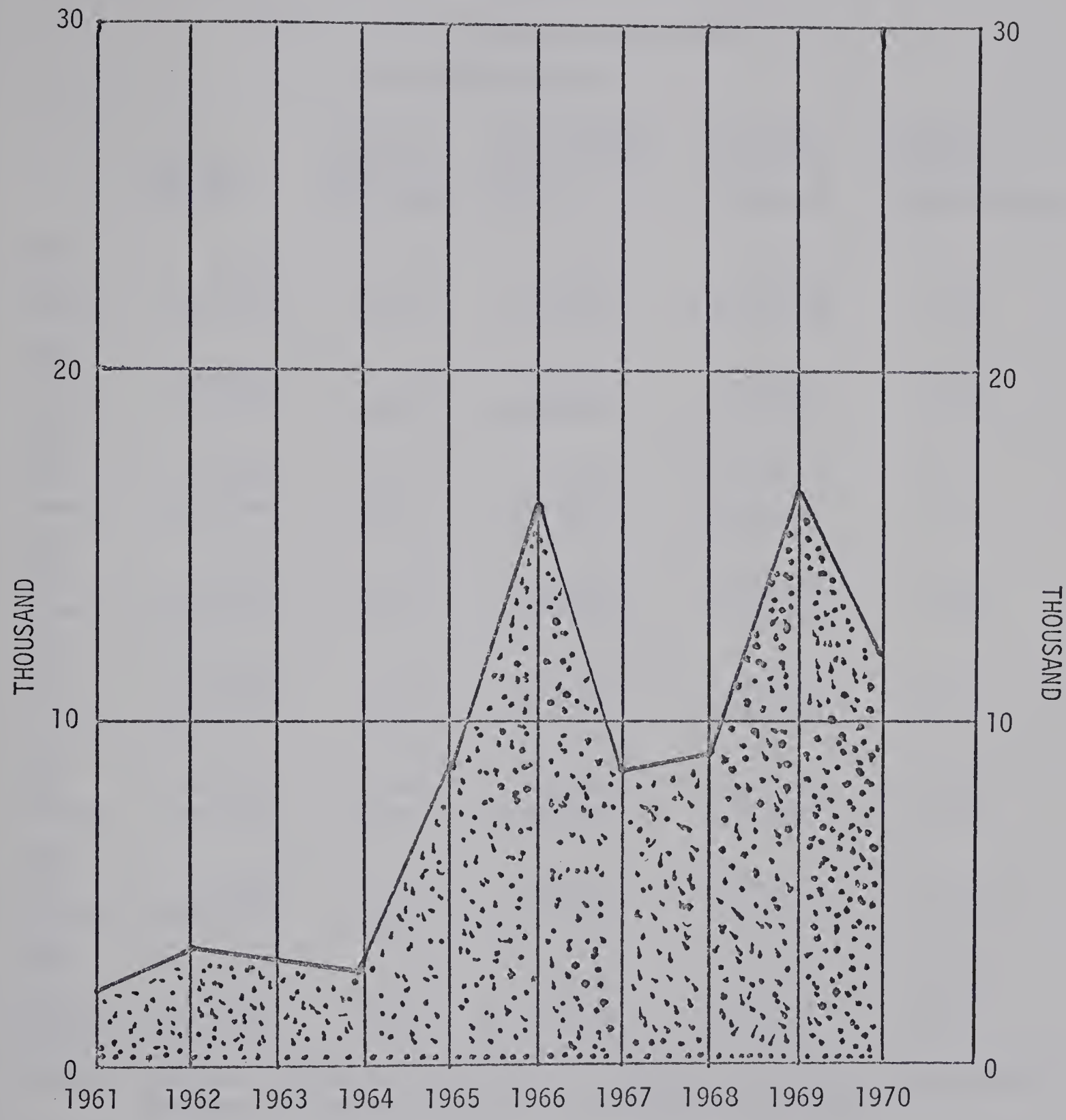
[1] Carr, D.W. and Associates Ltd., Vol. V op. cit. p. 7-2.

[2] Data on typical exploration costs is given in: Aho, A.E., "The Anvil Project," The Northern Resources Conference Transactions, (Whitehorse: 1969) p. 28. and in Department of Indian Affairs and Northern Development, Prospectus North of 60, (Ottawa: Queen's Printer, 1970), p. 3-5.1.

FIGURE II

MINERAL CLAIMS RECORDED - YUKON TERRITORY



Source: Prospectus North of 60, op. cit., 1970.

TABLE NO. 7

LABOUR COSTS FOR CONTRACT DRILLING[1] IN THE MINING INDUSTRY

	Footage Drilled	Average No. of Employees	Total Wages and Salaries Paid	Average Wages and Salaries	Labour Cost Per Drilled Foot
1952					
Y.T.	3,306	43	85,521	3,563.38	2.59
Canada	5,180,783	2,345	7,119,714	3,036.12	1.37
1955					
Y.T.	39,046	18	82,945	4,608.06	2.12
Canada	6,443,641	2,840	9,852,432	3,469.16	1.53
1958					
Y.T.	12,361	6	33,894	5,649.00	2.74
Canada	4,426,594	1,717	6,921,761	4,031.31	1.56
1960					
Y.T.	14,362	10	50,173	5,017.30	3.49
Canada	5,521,211	1,912	7,977,782	4,172.48	1.44
1963					
Y.T.	25,606	15	112,077	7,471.18	4.37
Canada	5,549,733	1,926	7,895,202	4,146.00	1.43
1965					
Y.T.	89,001	56	445,082	7,947.89	5.01
Canada	7,404,834	2,776	14,052,064	5,661.98	1.89
1967					
Y.T.	57,656	38	245,127	6,450.71	4.25
Canada	6,957,269	2,669	14,909,834	5,586.29	2.14
1968					
Y.T.	87,604	67	435,675	6,502.61	4.97
Canada	10,029,625	2,985	18,781,325	6,291.90	1.87

Source: Dominion Bureau of Statistics, Contract Drilling for the Mining Industry, Annually, 1952-1968, Catalogue No. 26-207.

Note: [1]Drilling operations conducted by contractors who employed diamond drills only and which were confined chiefly to the testing of metalliferous deposits.

the lack of data. However, the next section presents total preproduction costs for three Yukon mines and estimates of input usage will be given for the preprodution costs of these mines.

The Preproduction Stage: Development

The development stage begins when the company's examination by drilling, testing and feasibility studies indicates substantial ore reserves with a sufficient mineral content to justify the investment decision. There may be a considerable time lapse between the discovery and proving of an ore body and the decision to invest. The Cassiar Mine at Clinton Creek was optioned by the company from Conwest in 1957 and studies and testing were conducted until market conditions justified the development of the mine in 1965-1967.

The breakdown of expenditures for the preproduction phases of the three major mines developed between 1965 and 1970 is presented in Table 8. Two other mines, Mount Nansen Mines Limited and Arctic Gold and Silver Mines Limited were also developed in 1968 but as they shut down within a year of operation, information about their preproduction costs are not available. No information is presented for Venus Mines which began operation on a small scale in 1970.

There does not appear to be a standard procedure for differentiating between exploration and development costs so that the expenditures on the exploration phases of the three mining companies in Table 8 are not wholly comparable. It appears, however, that minimum estimates of exploration costs range from less than 10 per cent of total preprodution costs to more than 25 per cent for the new

TABLE NO. 8

EXPLORATION AND DEVELOPMENT COSTS FOR THE MAJOR NEW MINES IN THE YUKON 1965-1970

	New Imperial Mines $	Cassiar Asbestos Mining Corp. $	Anvil Mining Corporation $
Exploration and Development			
Feasibility & consulting			1,367,000
Geological & geophysical	75,000		510,000
Drilling	600,000	814,000	
Stripping		775,000	3,034,000
Overhead costs		2,425,000	
Other	393,490[1]	1,686,000[1]	1,804,000[1]
Mine Preparation	465,000		
Mining Equipment	1,186,000	2,900,000	4,542,000
Townsite	330,000	5,120,000[2]	6,579,000[2]
Plant construction			26,591,000
Shop	310,000	1,600,000	
Mill	3,321,000	22,195,000[3]	
Power	260,000	2,250,000	
Roads, bridges	40,000	2,080,000[4]	
Water	451,000		
Office	220,000	350,000	
Other	700,000	1,600,000[5]	927,000[3]
Other		50,000[6]	10,306,000[4]
Other			15,812,000[5]
Total Preproduction Expense	9,562,000	33,080,000[7]	71,471,000[6]

Sources: "Preproduction Expenses," Canadian Mining Manual, (Gardenvale: National Business Publications, 1969), pp. 14 & 15, and Cassiar Mining Corporation Profile (mimeo) undated, and Personal Communications with E.M. Lehbauer, Anvil Mining Corporation Limited, Faro.

TABLE NO. 8 CONTINUED

Notes: New Imperial Mines

[1]Cost of purchasing stakes.

Cassiar Mining Corporation

[1]Includes 67,000 for aerial mapping and survey, 21,000 for ore and soil testing, 22,000 for water investigation, and 319,000 for temporary camp facilities.

[2]Includes 3,900,000 for townsite housing and servicing and 1,220,000 for social and commercial facilities.

[3]Includes 6 million for the mill building, 1,225,000 for a tramline, 2,140,000 for a dryer building and 1,300,000 for dry rock storage.

[4]Includes 210,000 for the Yukon River Skyline and 1,100,000 for a bridge.

[5]Crushing Plant.

[6]Communications.

[7]This total includes 1,080,000 dollars contributed by the territorial and federal governments for road, school and hospital facilities.

Anvil Mining Corporation

[1]Start-up costs.

[2]Townsite facilities represent 4,500,000 dollars for housing and 2,057,000 for social and commercial facilities. Additional facilities to be built include 670,000 for housing and 540,000 for commercial facilities.

[3]Land, buildings, and field equipment.

[4]Other major equipment.

[5]This represents unexplained expenditure on exploration and development.

[6]This total includes investment by the territorial and federal government such as a school costing 912,000 dollars.

Wellgreen mine now being developed by the Hudson-Yukon Mining Company.[1]

This means that about three-quarters to nine-tenths of total preproduction expenditure can be attributed to the development of mining and infrastructural facilities. Although the Dominion Bureau of Statistics collects information only on the operating phase of the mining industry, we can develop some estimates of the importance of different inputs.

The Vice-President of Anvil Mining Corporation stated that the share of labour in the preproduction stage of the Anvil mine was 16 million or one-third of the total spent by 1969. This would be mainly for construction labour which is usually non-resident in the Yukon.[2]

Equipment and materials were estimated as 60 per cent of total preproduction expenditure by Anvil. Mining equipment represented 9 per cent of this and all major equipment appears to represent about 15 per cent. Thus on the basis of the Anvil mine, the share of labour was 33 per cent, the share of machinery and equipment was 15 per cent[3] and the remaining 52 per cent represents supplies and materials and other expenditures such as consulting services.

The proportion of total preproduction expenditure allocated to development of infrastructural facilities is worth considering because

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[1]The Wellgreen figures are calculated from Yukon Star, (Whitehorse: May 6, 1971)

[2]Aho, A.E., op. cit. p. 29.

[3]Mining equipment represented 12.4 per cent of preproduction expenditure by New Imperial while 9 per cent of the Cassiar investment was used for mobile hydraulic and automatic equipment only.

future mining developments may be able to utilize existing facilities and avoid these expenditures. New Imperial Mines used only 3 per cent of preproduction expenditure on townsite facilities since the labour force lives in Whitehorse, only 9 miles from the mine. Townsite facilities at Anvil and Cassiar are costed at 9 per cent and 20 per cent respectively of preproduction costs. In terms of cost per employee, this represents 2,050 dollars for New Imperial, 19,470 dollars for Cassiar, and 27,640 dollars for Anvil.

The development of a planned non-permanent town at the Wellgreen mine is an important development for the increase in social facilities necessary to attract and keep a labour force contributes greatly to the cost of a mining operation if the social overhead capital must be written off within a short period of time. The Wellgreen mine has a life expectancy of five years and then the trailer facilities will be moved. Investment in townsite facilities will be substantially more than 5 per cent of preproduction costs.

Investment in other forms of infrastructure has not been as important since the public sector pays for much of this. Main roads are completely paid for by the Department of Indian Affairs and Northern Development while access roads to mine sites receive two-thirds of the cost from the Department. Tote or minimum standard access roads for exploration and permanent airstrips may receive up to 50 per cent of the cost from government.[1]

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[1] Details on government support for the mining industry are available in many sources. One brief source is Prospectus North of 60, op. cit.

The Operating Phase

The most important phase of mining activity is the operating stage which includes exploration and development expenditures capitalized over time. Only exploration and testing programs of companies which do not proceed to open a mine would not be accounted for in operating costs of the Yukon industry.

Development of cost functions for the Yukon mining industry is neither feasible nor desirable at this time. The number of operating mines is very limited and only one major mine has been in operation longer than five years. It will be feasible to develop time series studies in the future but this study is restricted to showing the change in the composite input structure of the mining industry between 1961 and 1969. The emphasis is on a cross section analysis in 1969 which examines the three kinds of mining operations outlined in the introduction to this chapter.

The introduction to this chapter suggested that the mining industry was very heterogeneous in the kind of inputs used so that only limited aggregation was possible. The most beneficial and aggregative cost functions that could be developed would be those distinguishing between open-pit and underground operations. The distinctive features of these two kinds of operation, which are quite different in the quantity and kind of inputs used have already been noted. The per unit value and usual size of deposits of different minerals makes it possible to classify minerals into one of these two categories. Copper-molybdenum, molybdenum, large lead-zinc mines and small nickel mines would

likely be extracted by the open-pit method while copper with lead or zinc, tungsten, mercury, small lead-zinc mines and silver-gold mines would be underground operations. Distinguishing between small and large lead-zinc mines takes account of economies of scale in extraction.[1]

Asbestos, iron ore, and uranium mines do not fit readily into either category and should be calculated separately. Although the Yukon has enormous iron ore deposits, transport costs and market conditions are such that they are unlikely to be exploited for many years, so that a cost function for asbestos mines is the only additional function required.

The authors of a recent study used these divisions to determine operating costs as a function of one variable; the size of reserves. These functions are presented in an appendix so that the general cost differentials between these main industry groups can be examined. Naturally, there are a number of problems involved in attempting to adjust these simple functions to northern mining conditions. The only detailed examination available of incremental costs for northern mines was based on data in the fifties.[2] These functions are not examined

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[1]The categorization of minerals into open-pit and underground functions has been developed by Harris, D.P., Freyman, A.J., and Barry, G.S., "The Methodology Employed to Estimate Potential Mineral Supply of the Canadian Northwest ... An Analysis Based Upon Geologic Opinion and Systems Simulation," Mineral Information Bulletin MR 105 (Ottawa: Department of Energy, Mines and Resources, 1970). The authors suggest that lead-zinc deposits larger than 10 million tons and nickel deposits less than 10 million tons would have cost structures similar to open-pit operations.

[2]Dubnie, A., "Some Economic Factors Affecting Northern Mineral Development in Canada," Mineral Information Bulletin MR 38, (Ottawa: Department of Mines and Technical Surveys, 1959).

for they may be useful for estimating the required grade and size of mineral deposit necessary for a viable operation but they contribute very little as input for impact studies and related policy questions. A more detailed breakdown of inputs used is needed.

The approach used here is to designate three mines as representative of these three main industry groups. While it would obviously be desirable to have a number of mines included in each group, this is not possible since data is available for only these three mines. It is assumed that the input costs and the proportion in which inputs are used would not only be typical for each group but would likely apply to future mining developments.

United Keno Hill Mines Limited represents a small underground operation which exploits an ore with a high per unit value mineral content. Cassiar Asbestos Corporation Limited represents an asbestos mine and New Imperial Mines Limited represents an open-pit operation. Ideally, Anvil Mining Corporation would be the best example of an open-pit mine for it represents the kind of large scale, low grade mine which is becoming more economic with technological and market changes. However, the New Imperial mine can be examined as an initial approximation of the input structure of an open-pit operation.

A cost breakdown by category is presented for the mining and milling sequences for the three companies. Secondly, a cost breakdown by input category is given for the milling operation in each mine. These two stages are then combined for each mine and compared in Table 13. Finally, input costs are aggregated so that a comparison can be made with the inputs used in 1961.

Tables 9, 10 and 11 present a cost breakdown for the mining and milling stages of the Cassiar, New Imperial and United Keno Hill mines. To provide some measure of comparison, United Keno Hill's operations are presented for 1961, 1963 and 1966, the last year for which data has been published.

The differences in operating costs between these types of mines are clearly attributable to the mining operations since milling costs are not significantly different. Mining costs in the underground mine are more than 50 times as great as in New Imperial's open-pit mine. While this can be partially attributed to the techniques used, the higher rate of extraction in the open-pit mine (New Imperial extracts 6 times as much per day as United Keno Hill), allows it to achieve economies of scale. Thus hauling and pumping, which are standard procedures in all mining operations, are substantially higher in cost in the underground mines.

Fortunately, a cost breakdown by input category is available for the milling facilities at each mine (See Table 12). As United Keno Hill Mines Limited has been operating for a number of years, it is possible to examine the changes in costs for this mine. Of the three major input categories, only labour's share has increased. This may be partially explained by a 20 per cent decline in the quantity of tons milled between the two periods, but wages and salaries per employee have also been increasing quite rapidly in the Yukon. Labour costs are quite high for the milling sequence in each mine. It seems surprising to find that the highest share of labour is 43 per cent at the New Imperial mine, since it is generally assumed that open-pit

TABLE NO. 9

OPERATING AND COST DATA FOR CASSIAR ASBESTOS CORPORATION LIMITED

Mining (1969		Milling (1970)	
Tons per day ore	3,600	Mill capacity (tons per day)	4,000
Tons per day waste	10,000	Current throughput (tons per day)	3,000
Pit Employment	30	% Recovery	70
Days worked per week	12 shifts	% Grade of concentration	100
Drill costs of ore		Process	Screening Aspiration
per foot	$0.50		
per ton	0.03		
Drill costs of waste			
per foot	0.40		
per ton	0.02		
Mining Costs per Ton (dollars)		**Milling Costs per Ton (dollars)**	
Blasting	0.05	Crushing (drying)	0.48
Loading	0.109	Assay	0.06
Hauling	0.109	Supervision	0.09
Pump	N.A.	Maintenance	0.52
Supervision	N.A.	Burden/overhead	0.93
Maintenance	N.A.	Storage/shipping	0.11
		Tailing disposal	0.03
		Bagging and utilizing	0.98
		Operating	0.33
		Power	0.48
TOTAL	N.A.	TOTAL	4.01

Source: "Operating and Cost Data Canadian Open Pit Mines" Canadian Mining Manual op. cit. 1970, and "Operating and Cost Data Canadian Milling Plants" Canadian Mining Manual op. cit. 1970.

TABLE NO. 10

OPERATING AND COST DATA FOR NEW IMPERIAL MINES LIMITED

Mining (1968)		Milling (1970)	
Tons per day ore	2,900	Mill Capacity (Tons per day)	2,500
Tons per day waste	9,600		
Pit Employment	40	Current Throughput (Tons per day)	2,500
Days/Work Week	5 2/3	% Recovery	93
Drill Costs of Ore		% Grade of Concentrate	30
Per Foot	1.40		
Per Ton	0.087	Process	Flotation
Mining Costs per Ton (dollars)		**Milling Costs per Ton (dollars)**	
Primary drilling	0.087	Crushing	0.16
Secondary drilling	0.004	Grinding	0.32
Blasting	0.070	Conveying	0.08
Loading	0.080	Flotation	0.22
Hauling	0.086	Assay	0.03
Pump	0.004	Drying	0.08
Supervision	0.019	Supervision	0.10
Maintenance	incl.	Other	0.23
Tractor and Grader	0.012		
Engineer and Geologist	0.017		
Mine Roads	0.009		
TOTAL	0.388	TOTAL	1.22

Source: Same as for Table No.

TABLE NO. 11

MILLING OPERATING AND COST DATA FOR UNITED KENO HILL MINES LIMITED

Milling	1961	1963	1966
Mill capacity (tons per day)	550	550	550
Current throughput (tons per day)	540	550	400
% Recovery	82.5Pb	93.8	96.29
% Grade of concentrates[1]	70Pb	484	69.69
Process			
Milling Costs per Ton (dollars)			
Crushing	0.39	0.32	0.38
Grinding	0.89	0.63	0.82
Cyanidation	1.46	1.22	1.35
Flotation	0.70	0.65	0.66
Assay	0.12	0.14	0.21
Supervision	0.13	0.14	0.14
Maintenance	0.17	0.16	0.25
Concentrate handling	0.63	0.64	0.67
Other	0.36	0.79	0.27
TOTAL	4.65	4.69	4.75

Source: "Operating and Cost Data Canadian Underground Mines" Canadian Mining Manual op. cit. 1961, p. 80 & 81, 1963 and "Operating and Cost Data Canadian Milling Plants" Canadian Mining Manual 1961, p. 114 & 115, 1963, 1964, 1966.

Note: [1]70% lead in 1961, 69.69 oz. silver in 1966, and 484 oz. silver in 1963.

TABLE NO. 11 CONTINUED

MINING OPERATING AND COST DATA FOR UNITED KENO HILL MINES LIMITED

Mining	1959 Elsa Mine	1959 Hector-Calumet-Jock Mines	1963 All Mines
Tons per day ore	91	386	550
Tons per day waste	52	165	320
Stoping employment	18	86	92
Days/work week	---	---	
Stoping costs per ton (dollars)	6.49	8.51	---
Mining Costs per Ton (dollars)			
Development	4.76	4.05	3.80
Stoping	6.04	7.00	4.24
Hauling	1.80	2.25	2.65
Hoisting	1.70	0.79	1.10
Pumping	0.55	0.15	0.18
Ventilating	0.02	0.00	0.04
Other	1.16[1]	0.25[2]	5.23[3]
General	4.40	3.83	6.16
TOTAL	21.84	19.24	25.52

Source: "Operating and Cost Data Canadian Underground Mines" Canadian Mining Manual op. cit. 1961, p. 80 & 81, 1963 and "Operating and Cost Data Canadian Milling Plants" Canadian Mining Manual 1961, p. 114 & 115, 1963, 1964, 1966.

Notes:

[1] Includes $0.92 for timber maintenance.

[2] Diamond drilling.

[3] Materials.

TABLE NO. 12

COST PER TON OF MAJOR INPUTS IN MILLING FACILITIES, YUKON

Inputs	Cassiar Asbestos (1970)	New Imperial (1970)	United Keno Hill Mines (1959)	(1966)
Labour	$0.74	$0.52	$1.20	$1.50
Materials	1.20	0.41	2.06	1.78
Power	0.48	0.29	0.81	0.62
Miscellaneous	0.13	----	0.58	0.85
TOTAL	(2.55)[1] 4.01	1.22	4.65	4.75

Source: "Operating and Cost Data Canadian Milling Plants" Canadian Mining Manual, op. cit. 1961, pp. 114 & 115, 1970, pp. 62 & 63, 68, 69.

Notes: [1]The total cost per ton for the milling stage is given in the source as 4.01 dollars which equals total milling costs given by stage of operation in Table 9. However, the value of the inputs for Cassiar add up to only 2.55 dollars a ton.

mining is the most capital-intensive. However, the distinctive features in the different kinds of mining operations seem to be mainly related to the mining stage as milling procedures are more homogeneous. Another reason for the high proportion of costs attributed to labour at the New Imperial mine may be the relatively small scale of the open-pit operation and its location at Whitehorse where power and materials are cheaper.

Labour costs represent 31 per cent at the United Keno Hill mill and only 18 per cent at the asbestos mill. The actual share of labour in the total milling costs of the Cassiar mine is difficult to measure for as the footnote on Table 12 points out, total milling costs are given as 4.01 dollars per ton but the total of the input entries is equal to only 2.55 dollars per ton. Using this latter figure, labour's share of total milling costs at Cassiar is increased to 29 per cent.

A breakdown of input costs for all stages of these three mining companies is given in Table 13. If the estimations given, which are explained in the footnotes of the table, are reasonably accurate, then the share of labour as a percentage of the value of all input costs changes somewhat from its share of milling costs. Labour's share of total input expenditure increases for United Keno Hill Mines and declines for the Cassiar and New Imperial operations. The relative share of labour in input expenditure is now in the order suggested earlier. The underground operation is more labour-intensive and thus the share of labour in total input expenditure is more than twice as large as the share of labour at the New Imperial open-pit mine. As the share of labour in total input expenditure has been based on

TABLE NO. 13

PERCENTAGE DISTRIBUTION OF COSTS OF INPUTS USED IN THREE YUKON MINING COMPANIES-1969

	United Keno Hill Mines Ltd. (1970)	Per cent of Total Revenue	Cassiar Asbestos Corporation Ltd. (1969)[1]	Per cent of Total Revenue	New Imperial Mines Ltd. (1969)	Per cent of Total Revenue	Weighted Average Percentage of Inputs
	(000's) $		(000's) $		(000's) $		
Revenue[2]	7,608		37,527		11,755		
Input Expenditure							
Labour[3]	2,927	38.5	8,161	21.7	1,688	14.4	22.5
Capital	1,255	16.5	10,349	27.6	5,621	47.8	30.3
Subtotal		55.0		49.4		62.2	52.8
Inputs Purchased From Other Industries[4]							
Fuel and Electricity[5]	401	5.3	1,500	4.0	N.A.	N.A.	4.2[6]
Supplies, Materials and Unexplained[7]	751	9.9	7,168	19.1	2,065	17.6	17.5
Business, Financial and Other Services	2,274	29.9	10,349	27.6	2,381	20.3	26.3
Subtotal		45.1		50.7		37.9	47.2

Sources: Annual Report 1969, (Vancouver: New Imperial Mines Ltd., 1970), and Eighteenth Annual Report 1969, (Toronto: Cassiar Asbestos Corporation Ltd., 1970), and Annual Report 1970, (Toronto: United Keno Hill Mines Ltd., 1971), and 1970 Annual Report, (Edmonton: Alberta-Northwest Chamber of Mines-Oils-Resources, 1971), and Dominion Bureau of Statistics, Review of Employment and Average Weekly Wages and Salaries, Catalogue No. 72-201, 1967-69, and Personal communications with J.E. Ashton, United Keno Hill Mines Ltd., and S.K. Brigham, Cassiar Asbestos Corporation Ltd., and Price, Waterhouse and Co., The Yukon Mining Industry in 1969, (mimeo), undated.

TABLE NO. 13 CONTINUED

Notes: [1]Separate figures for the Clinton Creek mine in the Yukon were not available so the data is given for the Clinton Creek and Cassiar, British Columbia mining operations. As the Cassiar mine in British Columbia is fairly isolated in the north of the province and milled asbestos is trucked to Whitehorse from both mines, it was assumed that the average for both mines is the same as for the Yukon mine.

[2]This represents revenue from sales of concentrates and some interest and other income earned from investments.

[3]The share of labour is based on the average wages, salaries and employee benefits paid by all sections of the Yukon mining industry in 1969. This average of 11,256 dollars was calculated from the survey by Price, Waterhouse and Co. op. cit. Table 19.

[4]Some of the input expenditure attributed to purchases from other industries are likely internal to the companies as so few supporting services exist in the Yukon. Examples of this are the generation of its own electricity by Cassiar Asbestos Corporation and joint ownership with United Keno Hill Mines of Territorial Supply Co. and Yukon Coal Co. which act as supply agents and sources of coal for heating.

[5]Fuel and electricity figures were supplied by personal communication with the Mine Manager, United Keno Hill Mines Limited while the cost of electricity and fuel for Cassiar's mines were calculated from data supplied on 1970 costs by S.K. Brigham, Assistant to the President of Cassiar Asbestos Corporation Limited.

[6]The Dominion Bureau of Statistics has provided some information for all phases of the metal and non-metal mining industries in the Yukon in 1968. The ratios are larger than those given in this table since they are based on sales revenue only and thus would add up to more than 100 per cent. However, the discrepancy is quite large between the two ratios for fuel and electricity with fuel and electricity purchases representing 9.3 per cent in 1968 and only 4.2 per cent in 1969. The 1968 figures are taken from personal communication with D.F. Heney, Energy and Minerals Section, Dominion Bureau of Statistics.

[7]These ratios could not be calculated from the information available and represent the residual from the difference between total input expenditures and the sum of other input expenditures.

average wages, salaries and benefits received by mining employees in the Yukon in 1969, it is likely that the labour's share has been underestimated in the more capital-intensive open-pit and asbestos operations and overestimated in the more labour-intensive underground mine. United Keno Hill Mines has a greater proportion of its labour force in the less skilled occupations than does Cassiar and New Imperial. While it is difficult to measure the difference in total income paid to labour, it appears that the adjustments would be less than 10 per cent for any company.[1]

The corresponding shares of capital as a percentage of total input expenditures in each mine are in an inverse order to the shares of labour. Thus, capital expenditures are largest at New Imperial where labour's share of input expenditure is the lowest. The share of capital as a percentage of input expenditures in United Keno Hill Mines is quite low because the profit margins for this company have been negligible in recent years. The share of capital at the New Imperial mine has been very high primarily due to a large profit margin. As initial proven reserves at this mine were not very large, the company probably

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[1]The wage schedules for the Yukon mines indicate that underground labour, general labour and miners' helpers received about 3.50 dollars an hour in 1970. Heavy duty equipment operators received 4.25 to 4.35 dollars an hour and mechanics slightly more. Thus, the labour force in the capital-intensive mining stage of an open-pit operation might receive around 20 per cent more than in an underground mine. As labour rates in the milling sequence of each of the mines are fairly uniform, the average wage and salary receipts per employee would likely be less than 10 per cent between types of mines. See agreements between the mining companies and the United Steelworkers of America and "Forces Report (Offices, General)," Canadian Mining Manual 1970, op. cit. pp. 119 to 120 and "Underground Labour Distribution," Canadian Mining Manual 1969, op. cit. pp. 42-44.

made the mine investment decision on the basis of large potential profits.

Inputs purchased from other industries are probably not accurately broken down and some of the input expenditures attributed to business, financial and other services should probably have been included with supply and material purchases. The large proportion of total input expenses used for business, financial and other services at the United Keno Hill and Cassiar operations is largely due to the costs of transportation to railhead and beyond. Fuel and electricity estimates are probably fairly accurate as they are based on published costs for 1970 operations.

The significance of these input ratios for the Yukon and Canadian economies is examined in the next chapter. The remainder of this chapter is concerned with an examination of the changes in input ratios since 1961 (See Table 14). While the mining industry is so differentiated, there is little merit in projecting future input usage for any mine on the basis of the present average input ratios. However, in view of the mineral potential and market conditions, the kind of minerals produced now will likely provide the main thrust in future development, and input ratios may not change drastically.

The relative shares of the different inputs purchased from other industries should be used with a great deal of caution for little information was available on which to base these figures. It would appear that the proportion of fuel and electricity has declined since 1961 although there has been an increase in the amount of machinery and equipment used in mining operations. The amount spent on business,

TABLE NO. 14

PERCENTAGE DISTRIBUTION OF COSTS OF INPUTS USED IN MINING,
CANADA AND THE YUKON, 1961

	PERCENTAGE OF TOTAL				
	Yukon	Canada			
Factors Employed in Mining	Mining[1]	All Mining	Base Metal[2]	Other Mining[2]	Asbestos Mines
Labour costs[3]	36.6	24.3	25.7	50.0	26.0
Net income of unincorporated businesses	N.A.	0.3	0.1	0.4	----
Capital costs[4]	26.7	44.5	56.2	26.5	45.0
Subtotal	63.3	69.1	82.0	76.9	71.0
Inputs Purchased From Other Industries					
Fuel and Electricity	6.2	4.5	2.1	5.5	4.4
Materials and supplies	9.6	12.9	9.5	10.6	14.9
Financial, business, and other services	20.9	13.5	6.4	7.0	9.7
Subtotal	36.7	30.9	18.0	23.1	29.0

Sources: Compiled from Dominion Bureau of Statistics, The Input-Output Structure of the Canadian Economy, 1961, Volume II, Catalogue No. 15-502. (Ottawa: Queen's Printer, 1969), and the Annual Report 1961, United Keno Hill Mines, (Toronto: 1961), and Dominion Bureau of Statistics, General Review of the Mineral Industries 1962, Catalogue No. 26-201, June, 1966.

TABLE NO. 14 CONTINUED

Notes:

[1]The distribution of inputs for the Yukon mining industry was estimated from published data on principal statistics and the other figures based on the position of United Keno Hill Mines which produced more than three quarters of the regional output.

[2]Base metal mines and other metal mines encompass all metal mining which was almost the sole mineral output in the Yukon until 1968.

[3]Wages, salaries, and other labour income.

[4]The cost of capital is calculated as the sum of profits, investment income and depreciation.

financial and other services includes some costs which are normally provided by other industries but are integrated within the Yukon industry. This is due to the lack of supporting services in the Yukon. Materials and supplies purchased as a percentage of total input expenditure appears to have increased substantially since 1961 but, as these ratios were calculated as the residual from the difference between total input expenditures and the sum of other input expenditures, little confidence can be placed on these ratios.

The most important shift in input ratios since 1961 has been the relative increase in capital-intensity. The three companies examined have gross capital/output ratios of 1.47 for United Keno Hill Mines Limited, 1.23 for Cassiar and .7636 for New Imperial. Anvil Mining Corporation has a very high gross capital/output ratio for the preproduction expenditure/output ratio is 2.58 and further investment has been undertaken since the mine opened. Gross capital, which represents the accumulated total of investments over the life of the mine, is significantly different from net capital stock only in the case of United Keno Hill Mines, for the other mines have accumulated only a few years of capital depreciation. The ratio of net capital stock to value of production for United Keno Hill Mines is only 0.21. Thus it appears that the net capital/output ratios are significantly larger for the new types of mines in the Yukon. While the net capital/output ratio is unavailable for the placer gold operations, it would be reasonable to expect that they had very low net capital/output ratios. Assuming that the gross capital/output ratios in the placer gold mines were no larger than the ratio for United Keno Hill Mines in

1961, the weighted gross capital/output ratio[1] of approximately 1.8 for the whole industry in 1969 was more than 50 per cent greater than the 1961 ratio.

One result of this has been an increase in the proportion of total input expenditures in the Yukon mining industry attributed to capital. Capital costs have increased from 26.7 per cent of total input costs in 1961 to 30.3 per cent in 1969. Undoubtedly, the share of capital will be even higher once Anvil's input costs are considered for it has maintained a high operating profit since beginning operations.[2]

The quantity and value of output per employee has increased and consequently, labour's share of total input costs has fallen despite a substantial increase in per capita income for mining personnel. Labour's share of total input expenditures for the Yukon industry in 1961 was 36.6 per cent indicating labour costs were a much more important factor in the Yukon than in the Canadian industry. By 1969, the average share of labour in total input expenditure was only 22.5 per cent, a drop of slightly more than one-third.

The share of capital and labour in total primary input[3] costs

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[1]The references to the Yukon mining industry in 1969 are usually based on the weighted averages calculated from the three companies examined in Table 13. In this case, however, the preproduction/output ratio for Anvil Mining Corporation has been included.

[2]Quarterly statements for Anvil Mining Corporation Limited are given in the Northern Miner, August 5, 1971 and the Whitehorse Star, May 6, 1971.

[3]Primary inputs are defined here to mean labour and capital and thus exclude inputs purchased from other industries.

of the Yukon industry has shifted in favour of capital. Labour received 58 per cent and capital 42 per cent in 1961, but by 1969, the ratios were almost reversed as labour received only 42.6 per cent and capital 57.4 per cent of total primary input costs.

While most of the change in the relative shares of these two factors can be explained by a shift to exploitation of minerals with a lower per unit value necessitating a larger scale of operation, there has also been a general substitution of capital for labour. The incentive to substitute capital for labour is quite strong for average Canadian wages and salaries tripled between 1947 to 1967 while average costs of capital were only twice as great in the same period.[1] The relative prices of labour and capital in the North are even more condusive to labour substitution. While transportation and climatic differences in the North increase the cost of capital, incremental labour costs, particularly in the form of supplementary income and housing and social requirements are relatively even greater.

Thus, the amount of capital per person employed in the mining industry has increased dramatically. The Canadian mining industry has had an increase in gross capital stock per person employed from 25,000 dollars in the immediate post-war years to more than 100,000 dollars by 1967 in 1967 dollars.[2] The three Yukon mining companies discussed, plus Anvil Mining Corporation, which together produced more than 90 per cent

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[1] Dawson, J., Productivity Changes in Canadian Mining Industries, Staff Study No. 30, (Ottawa: Economic Council of Canada, 1971), p. 14.

[2] Dawson, J., op. cit. p. 15.

of the value of output in 1969 had an average gross capital stock per employee of 160 thousand dollars.

The shift in the relative proportions of labour and capital and the kinds of capital investment changes the value of the mining industry to the regional and national economies. The purpose of the next chapter is to assess these changes.

CHAPTER FIVE

SOURCES OF MINING INPUT EXPENDITURES

Introduction

The purpose of this chapter is to examine the impact of the Yukon mining industry on the regional and national economies. It should be emphasized initially that the potential impact is much greater than the present impact.

Expansion of input demand as the mining industry grows could allow the development of many industries now below the 'threshold' of minimum economic size. At the same time, expansion of the Yukon economy by the leading sector does not imply the development of a sophisticated range of industries. The Yukon economy is likely to reach a stage of maturity, in the sense that all economically viable industries are developed, and still have only a few sectors with a limited degree of interdependence.

The impact of a leading sector on an economy depends, therefore, on the degree of interdependence created by that sector. This can be determined by examining forward and backward linkages.[1] The total potential linkage effects of an industry w can be represented as $\sum_{1}^{n} x_i p_i$

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[1] Hirschman, A.O., The Strategy of Economic Development, (New Haven: Yale University Press, 1963), p. 100. Hirschman defines backward linkage effects as derived demand or the inducement for domestic production of inputs needed by every nonprimary economic activity. Forward linkage effects are inducements to create industry which will use as inputs the output of every activity that does not cater exclusively to final demands.

where $x_i(i=1,2,\ldots,n)$ represents the net outputs of n additional industries linked to industry w and $p_i(i=1,2,\ldots,n)$ is the probability that each one of these industries will actually be set up as a result of industry w's existence.[1]

The mining industry like other intermediate primary producers, is characterized by high forward linkages and low backward linkages. Chenery and Watanabe[2] calculated the average linkage effects for Italy, Japan, and the United States in which backward linkages were expressed as the ratio of interindustry purchases to total production and forward linkages expressed as the ratio of interindustry sales to total demand. They found that metal mining had a backward linkage of 21 per cent and a forward linkage of 93 per cent around 1956.

Backward linkages calculated for the Yukon industry are substantially higher than this figure, which reflects the universal increase in the capital intensity of the mining industry since then. Table 14 shows interindustry purchases as 36.7 per cent of total input purchases in 1961. The transactions table presented in the appendix gives a backward linkage of 30.7 per cent in 1966 while the three mining companies considered in Chapter Three had backward linkages of about 40 per cent in 1969-70. The most important backward linkage in the Yukon industry is transportation services which represent half of the existing backward linkages.

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[1] Ibid., p. 101.

[2] Chenery, H.B. and Watanabe, T., "International Comparisons of the Structure of Production," in Hirschman, A.O. op. cit., pp.105-107.

It is fortunate that backward linkages are increasing for forward linkages, while potentially very large, are insignificant at present. Only coal sales and some purchases by the construction and service sectors can be considered as existing forward linkages. This represented less than one per cent in 1966. The impact on the regional or national economies from further processing will continue to be nearly zero until some of the mineral output is smelted and refined within Canada.

Returning to the impact of backward linkages to other industries, the effects are stronger but still limited in the regional economy.

The most comprehensive source for estimating the multiplier effects of mining input purchases is the transactions table developed by Carr and reproduced in the appendix. Unfortunately, as discussed in Chapter One, this table is not representative of the mining industry today since it does not take account of the large-scale mining developments since 1966. The assumptions made in Chapter Three about the feasibility of open-pit mines and their impact means that they must definitely be considered when examining linkages.

Essentially, the Carr transactions table examines the operations of the Yukon Consolidated Gold Corporation which has since shut down, and United Keno Hill Mines Limited which is considered in this study as one of the three distinct types of mining operations in the Yukon now.

There have been major changes in the United Keno Hill operation since 1966 when the transactions table was developed. Labour's share of 40.6 per cent of total input expenditures in 1966 was very substantial and one-third more than capital's share. Since then, the labour force

has been reduced from 500 employees producing 300 tons daily to only 216 employees producing 239.6 tons daily in 1969. Total revenue, the value of output per ton of ore and net profit have also been reduced. Thus, the ratios for United Keno Hill Mines given in Table 13 probably reflect the reduced role of primary inputs in this company by 1969.

Inputs purchased from other sectors of the Yukon economy in 1966 represent 21 per cent and direct imports represent another 10 per cent of total mining expenditure in the transactions table. United Keno Hill Mines Limited operates several underground mines which appear to have a greater impact on the regional economy than open-pit or asbestos mines. The Yukon Consolidated Gold Corporation, was also a labour-intensive operation which allocated a large percentage of its expenditures to the Yukon. The development of more capital-intensive mines and other changes in the nature of the industry and the typical input ratios since then reduces the value of the Carr transactions table and requires calculation of new input ratios.

In order to develop a more accurate estimation of the impact on the regional economy of the mining industry, it is necessary to consider not only the development of large open-pit mines but the leakages from labour and capital's share of the value of inputs. To provide information for public policy formulation, estimations of the linkages between the Yukon mining industry and the rest of Canada will also be considered.

The study by Price, Waterhouse and Co. which has been discussed in the introduction to Chapter Four involved a survey of the sources of

loan and equity capital, the supply of machinery and equipment and other supplies and services. While these data relate to all phases of the mining industry, this should not affect use of some of these figures.[1]

The Preproduction Stages: Exploration and Development

Returning to the format used in Chapter Four to examine mining costs, we can examine exploration, development, and operating phases. Exploration is difficult to quantify for it is conducted by a large number of firms. It appears that exploration funds by source are about 40 per cent Canadian, 40 per cent American, and 20 per cent Japanese, British and French.[2] No breakdown of exploration expenditures by source of input is attempted but it is likely that the level of exploration in the Yukon has increased to a volume sufficient to allow provision of many inputs from the regional economy. A good example of this trend is the number of helicopter companies which have located in the Yukon.

In contrast, the nature of the development phase results in only a limited impact on the Yukon. The major components of expenditures are wages and salaries, machinery and equipment, construction and

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[1] Other sources for the following discussion are, unless otherwise noted; Cassiar Asbestos Profile, op. cit. p. 2 and p. 4, Yukon Star, Whitehorse, May 6, 1971; Anvil Mining Corporation Limited, undated, Faro, and personal communication with K.G. Rizkally, Comptroller, Dawson Developments Limited and E.M. Lehbauer, Chief Accountant, Anvil Mining Corporation Limited.

[2] The Whitehorse Star, August 12, 1971, p. 4. These estimates were made by T.Elliott of the British Columbia and Yukon Chamber of Mines during presentation of a brief to a parliamentary committee studying Bill C-187, the Yukon Quartz Royalty Act. It was based on approximately 1000 companies operating in the two regions.

professional consulting services. Estimations based on the Anvil development at Faro, which represents twice as large an investment as any other Yukon mining development, credit labour's share as one-third with equipment and materials representing the other two-thirds. The share of mining equipment alone appears to vary from 9 to 15 per cent. On the basis of the Canadian average, construction-type equipment which represents about 73 per cent of total capital stock would be about 27 to 45 per cent of development costs, while the remaining 7 to 30 per cent represents supplies, fuel, etc.

It appears that the largest proportion of construction expenditures are directed to Western Canada, particularly British Columbia.[1] The erratic nature and lumpiness of investment in mining developments reduces the liklihood of major construction companies developing in the Yukon. Most construction companies register in the Yukon and import labour and equipment upon receipt of a contract. Several firms, such as Humphrey Construction and Dawson Developments Limited, located in Vancouver have received most of the major contracts. Alberta has been successful mainly in supplying housing, especially mobile facilities.[2]

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[1] Price, Waterhouse and Co., op. cit. attribute 88 per cent of contract work for all phases of the industry to American sources and only 12 per cent to the Yukon and the rest of Canada. As it was not clear what this total represented, it is not considered.

[2] General contractor for Anvil was Ralph M. Parsons of Canada and Humphrey Construction of Vancouver was general contractor for the Cassiar and Wellgreen mines. Versatile Mining Services Limited of Kamloops is doing the underground development at Wellgreen. While Dawson Developments Limited of Vancouver have received several major housing contracts, Alberta firms such as Nelson, Atco, and G.I.C. have received the major share of Cassiar housing contracts.

Yukon companies appear to receive contracts for access roads and other small projects. An optimistic assumption for the Yukon would be receipt of 10 per cent of construction contracts, by value with the other 90 per cent allocated to Western Canada.

Professional consulting services expenditures appear to be more dispersed than construction contracts, but again, were mainly located outside the Yukon. Anvil Mining Corporation used Hazen Research Company of Colorado, Galigher Company of Utah, Parson-Jurden Company of New York and a Vancouver firm for consulting and testing. Cassiar and Wellgreen used Canadian firms. The relative shares by source in 1969 were 78 per cent spent in British Columbia and the Yukon, 8 per cent in other parts of Canada and 14 per cent in the United States.[1]

Machinery and equipment purchases have been classified by source as nearly all Canadian with only 1 per cent going outside Canada.[2] Only 6 per cent is spent in the Yukon and British Columbia. Repair of machinery and equipment is an important component of mining expenditures but no information is available. As the Yukon lacks sophisticated supporting services and transportation is time consuming, most mines maintain extensive repair facilities. Thus, this item has probably been accounted for in other input expenditures.

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[1] Ibid., Table 18.

[2] Ibid., Table 18. There was no comment given in this study on these figures but the proportion allocated to Canada seems very high. The breakdown given probably represents the source of the distribution of machinery and equipment, not the source of the producer. There is no doubt, however, that expenditure on machinery and equipment represents a complete leakage of funds from the regional economy.

The proportion of wages and salaries received during the development phase and spent in the Yukon can only be guessed at but it is definitely less than the proportion for total wages and salaries in the operating phase. Most of the labour is recruited from British Columbia or Alberta and companies employing men in isolated mining regions often provide free transportation to southern centres for accumulated days leave. Thus, labour income spent in the Yukon may be very limited in this phase.

Other materials and supplies would probably be purchases in about the same ratios from within the Yukon and elsewhere as in the operating phases of mining development. A breakdown of supplies and materials, fuel and electricity and business, financial and other services is given in the next section.

Using these estimates and assuming that labour income spent in the Yukon would likely be less than 25 per cent, the proportion of exploration expenditures spent in the Yukon is probably about 15 to 25 per cent.

The Operating Phase

The operating phase has a greater impact on the Yukon economy since it creates a continuous input demand over a longer time horizon than the preproduction phases. Therefore, the inducements for development of backward linkages are stronger.

The most important mining input in the past has been labour but its share has been declining with the development of more capital-intensive mines. While the share of labour as a percentage of total input

expenditures in 1969 was only 22.5 per cent in the operating phase, one-third less than during the development phase, it has a much greater impact on the Yukon since the labour force in the preproduction phases tends to be more transient. Therefore, a much larger percentage of labour income in the preproduction phases is taken directly out of the Yukon.

The mobility of labour in operating mines is also quite high and the rate of turnover in the mining industry labour force is estimated as approximately 100 per cent annually. Thus, along with the usual direct spending of labour income outside a region in the form of travel and holiday spending, the transfer of savings is a significant leakage. The development of more extensive cultural and social facilities and other fringe benefits offered by the mining industry should reduce the leakage effect caused by labour mobility. Estimating the magnitude of leakages from labour income is not possible until more information is available on the use of this income.

The most important input group used in the Yukon mining industry now is capital, in terms of its share of total mining expenditures. While labour's share has fallen by one-third since 1961, capital's share of input expenditures has increased by more than 15 per cent. The share of capital can be expected to increase again for some years, without considering substitution of capital for labour, since 1969 represented only the second full year of operation for the Cassiar asbestos mine and the start of the Anvil mine. It will take some time to determine the profitability of these mines, especially as both mining companies are expanding operations in response to favourable market conditions.

Only one company, United Keno Hill Mines Limited, paid a dividend in 1969, the first time since 1965 while none of the other companies have yet to pay any dividends. Common dividends issued in 1969 were only 494 thousand dollars or slightly more than 1 per cent of total input expenditures. As United Keno Hill Mines Limited is effectively owned by Canadians, most of the dividend payments remained within Canada with only 32.2 per cent going to the United States.[1]

The development of new mines and the significant changes in the ownership characteristics of the Yukon mining industry require further consideration since profits and dividend payments in 1969 are certainly not going to be typical of the industry in the future. Table 15 lists the major known shareholders and the effective Canadian ownership in the six operating mines and one developing mine in 1970. For the five mines for which the percentage of effective Canadian ownership[2] is given, the average effective Canadian ownership content is 48.5 per cent. On the basis of the market value of total issued share capital of 250 million dollars for these companies, the effective Canadian ownership is 117 million dollars or 47 per cent.[3] Only 18 per cent of

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[1] Ibid., Table 8.

[2] Effective Canadian ownership is determined by the percentage of equity beneficially owned by Canadians after taking into account the foreign ownership of Canadian corporations holding a direct or determinable indirect investment.

[3] Ibid., Table 10. Additional information not presented in Table 15 is taken from the above source.

TABLE NO. 15

OWNERSHIP CHARACTERISTICS IN THE YUKON MINING INDUSTRY

	Value of Annual Production (000's $) Year	Expected Length of Operation	Expected Value of Reserves[1] (millions $)	Ownership Direct	% Share	% Primarily Canadian	% Primarily Non-Canadian	% Effectively Canadian
Anvil Mining Corporation Limited	28,863 (1970)	25 years[2] (proven)	1,827.0	Cyprus Mines Corporation (Los Angeles)	60.0		60	
				Dynasty Exploration Ltd.	40.0	40		39
New Imperial Mines Ltd.[3]	11,755 (1969)	5 years (proven)	148.5	Hudson Bay Mining & Smelting Co.	10.65 (33.3)[4]		10.65	
				Anmercosa Investments[5]	10.65		10.65	79 (55)[4]
				Sumitomo Metal Mining Co.[6]	3.0		3.0	
Cassiar Asbestos Corporation Limited[7]	12,701 Clinton Mine (1969)	25 years minimum	386.0	Bell Asbestos Mines[8]	23.4		23.4	
				Newmont Mining Corp. (Can.)[9]	13.2		13.2	
				Conwest Exploration Co.[10]	10.0			45
				Raybestos Manhattan Inc.[11]	10.0		10.0	
				James Hardie Asbestos Ltd.[12]				

TABLE NO. 15 CONTINUED

	Value of Annual Production (000's $) Year	Expected Length of Operation	Expected Value of Reserves[1] (millions $)	Ownership Direct	% Share	% Primarily Canadian	% Primarily Non-Canadian	% Effectively Canadian
United Keno Hill Mines Limited	6,864 (1969)	N.A.	8.4	Falconbridge Nickel Mines Limited[13]	48.4	48.4		55
Yukon Coal Company (Tantalus Butte Coal)	N.A.	N.A.	1.2[14]	United Keno Hill Mines Ltd. Cassiar Asbestos Corp. Ltd.	25 75	25 75		48
Venus Mines[15]	1.0[16] (1970)	5 years	4.8	Arcturus[17] Investment & Development Limited	14.0 (max)			N.A.
Hudson-Yukon Mines Ltd.[18]		5 years[18]		Hudson Bay Mining & Smelting Co.[4]	93.2		93.2	Approx. 25

Sources: This information has been gathered from The Financial Post, The Financial Post Survey of Mines 1970, The Financial Post, (Toronto: 1971), and Porter, J., The Vertical Mosaic, (Toronto: The University of Toronto Press, 1970), Table II (Appendix), and Hilker, R.G., The Whitehorse Copperbelt, Western Miner, July 1967, p. 41, and Northern Miner, Canadian Mines Handbook 1970-71, (Toronto: Northern Miner Press Limited, 1970), and Carr, D.W. and Associates Ltd., Vol. V, op. cit., and Price, Waterhouse and Co., op. cit., Table 10, and The Whitehorse Star, August 12, 1971, p.4.

TABLE NO. 15 CONTINUED

Notes: This table represents an incomplete breakdown of the ownership pattern of mining companies operating in 1970 except for the Wellgreen Mine operated by Hudson-Yukon Mines Limited which is scheduled to begin in September, 1971.

[1]The gross value of reserves has been calculated on the basis of the following prices:

Pb-Zn	$.15/lb.	Pb-Zn	Lead-Zinc
Ag	$1.75/oz.	Ag	Silver
Au	$35.00/oz.	Au	Gold
Cu	$.50/lb.	Cu	Copper
As	$200./ton	As	Asbestos

[2]Estimated from projected annual production for the first eight years of production and present proven and probable reserves (1970).

[3]New Imperial Mines ceased operations on June 30, 1971 retaining only 30 employees. New orebodies being developed should allow production to begin again on January 1, 1972. This was reported in the article, "Manpower Programs for New Imperial Crew," in the Whitehorse Star, Vol. 71, No. 52, July 8, 1971, p. 4.

[4]Hudson Bay Mining and Smelting Company is primarily owned by non-Canadian interests with seven of the nine directors being non-Canadian. Anglo-American Corporation of South Africa holds 28 per cent interest through its Canadian subsidiary, Anmercosa Investments. A one-third interest in the New Imperial Mine has been negotiated with Hudson Bay Mining and Smelting Corporation of Canada and Anglo-American Corporation of South Africa on August 3, 1971. This increases the foreign ownership share of New Imperial's operations to nearly half on the assumption that the shares of Anglo-American and Hudson Bay Mining and Smelting Company have an 80 per cent average foreign ownership.

[5]Anmercosa Investments is a wholly owned subsidiary of Anglo-American Corporation of Canada which is owned by:

Anglo-American Corporation of South Africa	30.3%
De Beers Consolidated Mining Limited	26.1%
Charter Consolidated Group	24.7%
The Investors Group	10.0%
Others	8.9%
	100.0%

TABLE NO. 15 CONTINUED

Notes: Continued

[6]Sumitomo Metal Mining Company is the Japanese mining company which has provided financing for development and has a long term supply contract with New Imperial Mines Limited.

[7]Cassiar Asbestos Corporation has a 75% interest in Territorial Supply Company Limited and United Keno Hill Mines controls the remaining 25%. Territorial Supply Company Limited serves as a supply and service agency at North Vancouver and Whitehorse, Yukon Territory and has a wholly owned subsidiary, Yukon Coal Company Limited.

[8]Bell Asbestos Mines operates as the sales representative for Cassiar products and is a subsidiary of Turner and Newall Limited of England.

[9]Newmont Mining Corporation of Canada Limited is a wholly owned subsidiary of Newmont Mining Corporation in New York.

[10]Conwest Exploration Company provides management services for the Clinton Creek operation.

[11]No ownership data is available for Raybestos Manhattan Incorporation.

[12]No ownership data is available for James Hardie Asbestos Limited.

[13]Falconbridge Nickel Mines Limited appears to have a substantial foreign ownership element and three of the eleven directors are non-Canadian. McIntyre Porcupine Mines holds a 37 per cent interest in Falconbridge and McIntyre in turn is 38.85 per cent owned by Superior Oil Company through its Canadian subsidiary, Canadian Superior Oil.

[14]As reserves are not known, a minimum estimate of three times the gross value of production in the four-year period, 1962 to 1965 was used.

[15]Venus Mines commenced operations in September, 1970.

[16]As Venus has only been producing since September, 1970 and production data for the first three months suggested gross value of production as $300,000, yearly gross value is estimated as one million dollars.

TABLE NO. 15 CONTINUED

Notes: Continued

[17]Reference was made to Arcturus Investment and Development Limited in the Third Annual Report, 1970, Venus Mines Limited, (N.P.L.), (Vancouver: 1970), but the ownership source is not known.

[18]Hudson-Yukon Mines is scheduled to commence production in September, 1971. The expected life of the mine is based on a five-year contract with Sumitomo Metal Mining Company of Japan.

the Yukon industry is more than 50 per cent effectively Canadian owned.

Canadian companies are most prominent in ownership control of the smaller mines with limited reserves while large foreign companies are providing the substantial investment funds needed to develop large scale mines. Therefore, Canadian ownership of the value of reserves has declined to only 42.5 per cent.

Equity capital has contributed 43 per cent of the net capital inflow between 1960 and 1969. Long term loan capital represented another 52 per cent and the rest was generated internally by the mining industry. Long term loan capital borrowed during the last decade was 92 million dollars of which British Columbia supplied 9 per cent, other parts of Canada 39 per cent, and non-Canadian sources provided 51 per cent. Interest paid on this loan capital during 1969 was 10 per cent to British Columbia, 55 per cent to other parts of Canada and 35 per cent to the rest of the world. Total interest payments by all companies active in the Yukon in 1969 amounted to 3.9 million or 10.6 per cent of all expenditures.

Leakages outside the Canadian economy from equity and loan capital payments were therefore, very significant in 1969 and are likely to increase in the future. Combined equity and loan capital payments in 1969 represented 11.6 per cent of total input expenditures of which 7.6 per cent were distributed within Canada and 4.0 per cent to non-Canadian sources. The amount remaining within the Yukon is presumed to be negligible.

The third major component of capital is expenditure on machinery

and equipment which is accounted for in the operating phase by depreciation allowances. Depreciation represented about 28.3 per cent of expenditures on capital in 1969. The sources for supply of machinery and equipment are mainly eastern Canada or the United States. The Price, Waterhouse and Co. study estimated that 6 per cent of the value of machinery and equipment purchases went to the Yukon and British Columbia, 93 per cent to other parts of Canada and only 1 per cent to the United States.[1] However, the Canadian share of these expenditures seems very high and as no comments are given for these percentages in the study, it is probable that the 99 per cent of machinery and equipment attributed to Canada has been determined on the basis of the source of the distributor, not the source of the producer.

The primary inputs of labour and capital both have important leakages, labour because it is still quite transient and the service and retail sectors are limited or rely heavily on imported goods. Interindustry purchases by the mining industry are therefore quite significant since they allow development of the other Yukon sectors and provide more scope for labour spending as well as creating much of the mining industry's impact on the regional economy.

The smallest group of interindustry purchases by the mining industry is fuel and electricity. The figures given for fuel and electricity purchases by the industry in Table 13 are probably less than their actual proportion although they are based on data from 1970.[2] A

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[1] Ibid., Table 18.

[2] See footnote 6 in Table 13 for fuel and electricity sales in 1968.

subsidiary of the White Pass and Yukon Railway Company operates an oil pipeline from Skagway, Alaska to Whitehorse and, consequently enjoys a virtual monopoly over fuel sales. Electrical power is supplied by the Northern Canada Power Commission or, in the case of the Cassiar mine, generated internally by its own thermal plant. Coal from the Carmacks region is used for heating and drying purposes at the United Keno Hill, Cassiar and Anvil mines. It appears that coal purchases represent one-half of one per cent or less of total input purchases while electrical sales, also wholly attributed to the Yukon, represent about 2.3 per cent of total input costs.[1] Fuel sales, representing about 2 per cent of total mining expenditures, should probably have no more than three-quarters of its value attributed as leakages to other parts of Canada. Thus, the mining industry's fuel and power expenditures create strong linkages with the rest of the regional economy.

The second group of interindustry purchases combined in Table 13 is supplies, materials and unexplained expenditures. As pointed out in Chapter Four, some of the items included with business, financial and other services should probably be classified with supplies and materials. Supplies and materials for production use by the industry have been broken down by source into 70 per cent from the Yukon and

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[1]The proportions of fuel and electricity were determined from total fuel and electricity purchases by calculating the ratio of the value of all fuel purchases to the value of electrical purchases in 1967 for the Yukon and Northwest Territories. The Dominion Bureau of Statistics combines fuel and electricity purchases by the mineral industries for both territories. Electricity generated internally by mining companies was valued at 2 cents per KWH. See Dominion Bureau of Statistics, General Review of the Mineral Industry 1966 and 1967, (Ottawa: Queen's Printer, 1968), Table 33B.

British Columbia, 29 per cent from other parts of Canada and 1 per cent from the United States.[1] This group of inputs is very important for the Yukon since they include many items which may potentially be produced within the region. Forestry products which represented 1 per cent of total input costs in 1966 were much less significant in 1969 as the expansion of the industry by open-pit mining does not increase demand for mine timber, used extensively in underground mines. It seems likely that most of the purchases of supplies and materials can be attributed to British Columbia and that less than one-fifth can be attributed to the Yukon. This represents approximately 3 to 4 per cent of total input expenditures.

The most important group of interindustry inputs is business, financial and other services. Within this group, transportation is the most significant input and its share is growing rapidly.

The development of large scale mines exploiting minerals with a very low per unit value results in a large increase in tonnage handled and in the share of transportation services in total costs. While the increase in the volume of rail shipments should result in scale economies, it is not certain how much is passed on to the mining companies in the form of lower rates since contracts with the White Pass and Yukon Railway Company are confidential.

Smelter, freight and marketing expenses are combined as one item in annual reports of mining companies but smelter and marketing charges are not likely to be very significant because of long term

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[1] Price, Waterhouse and Co., op. cit. Table 18.

contracts and other factors. Transportation to Vancouver and warehousing costs represented 27 per cent of total input costs for the Clinton Creek mine of Cassiar Asbestos Corporation, and approximately 25 per cent for United Keno Hill Mines Limited and 13 per cent for New Imperial Mines Limited. Average transportation costs for the three companies combined were 21 per cent of total input expenditures.[1] Costs for truck transport from the mines to Whitehorse average 6 cents a ton mile and represent 47.4 per cent of total transportation expenditures.

In terms of rail facilities and employment at Whitehorse, Skagway, and Vancouver, it appears that 35 per cent of rail and shipping services remain in the Yukon. Transportation costs from the Yukon border to Vancouver are probably equally split between Alaska and British Columbia. Using these estimates, the relative sources for the value of transportation services would be 13 per cent of total mining input costs within the Yukon and 4 per cent each allocated to Alaska and British Columbia.[2]

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[1] Representative transportation costs for the Yukon in 1968 are presented in D.C. Findlay, "The Mineral Industry of Yukon Territory and Southwestern District of Mackenzie, 1968," Geological Survey of Canada Paper 69-55, (Ottawa: Department of Energy, Mines and Resources, 1969), p. 3. Published rates for rail and boat transportation on 30,000 lb. carloads were 16 dollars per ton for lead and zinc concentrates and 17 dollars per ton for asbestos fibre in 1968.

[2] A new development which will reduce the impact on Vancouver as a receiving port is the development of Skagway and Whittier, Alaska as direct shipping ports to Japanese and German markets. The first shipments from these ports of this nature took place in 1969 and resulted in the loss of 20 per cent of the volume of ore concentrates from the Vancouver port. Ibid., Table 24.

Another input expenditure is tax payments to the federal and territorial governments. These were very small in 1969 but are likely to substantially increase in the next few years as the tax-free periods end and higher tax rates come into effect.[1]

Corporate taxes in 1969 were 1 per cent of total input expenditures for United Keno Hill Mines Limited because of the low profit levels and deductions for exploration activities. New Imperial Mines Limited paid no corporation taxes because of the three year tax exemption granted to new mines while Cassiar Asbestos and United Keno Hill Mines had no royalty payments in 1969. Thus the average share of input expenditures allocated directly to corporate tax and royalty payments was only 3.6 per cent. The total payments by all Yukon mining companies to the Yukon territorial government in 1969 in the form of mining royalties, property tax, fuel oil tax and leases and rentals were 454 thousand dollars or 1.2 per cent of mining revenue. Corporation income tax, federal sales tax and customs duties paid to the federal government by all Yukon mining companies in 1969 totalled 361 thousand dollars or 1 per cent of mining revenue, while non-resident dividend and interest taxes represent similar payments to the federal government.[2]

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[1] Proposed changes in the Canadian corporation income tax, mining company tax exemptions and the Yukon Quartz Royalty Act are likely to increase substantially the share of government in total mining costs.

[2] Ibid., Table 23.

Conclusion

It is possible to draw some general conclusions on the basis of the previous estimations.

The primary factors have increased their share of total mining input expenditures but the relative shares of labour and capital have changed drastically since the development of more capital-intensive mining operations. Thus, the impact on the Yukon of primary factor payments by the mining companies has almost certainly been reduced as payments to capital inputs in the form of long term loan interest, dividends and machinery and equipment purchases represent almost total leakage from the regional economy. While a significant proportion of labour income also leaves the regional economy directly, it can be assumed that nearly all of it remains within the Canadian economy. In contrast, the data given in this chapter suggest that one-third of capital expenditures are directed to non-Canadian sources. Thus, an increase of one per cent in capital's share at the expense of labour income represents a fall of one-third of one per cent in the direct impact on the Canadian economy. The leakages from capital spending may continue to increase as the large scale mines expand operations and Canadian funds provide only 40 per cent of present exploration expenditures.

The most significant change in interindustry purchases by the Yukon mining industry is the increased share of transportation. The actual linkage effect within the Yukon economy is quite large as nearly two-thirds of transportation expenditures have been attributed to the

regional economy in this chapter. Development of full ocean shipping port facilities at Skagway and Whittier, Alaska would remove the linkage effect of nearly one-fifth of transportation expenditures with British Columbia.

The other major input group which has important backward linkage effects on the rest of the Yukon economy is fuel and electricity purchases. Nearly two-thirds of total fuel and power spending remains within the local economy. However, this group represents only 4.3 per cent of total industry spending compared to 21 per cent spent on transportation inputs. Other major interindustry inputs appear to have little impact on the Yukon economy and it is unlikely that demand inducements by an expanding mining industry will be strong enough to create new kinds of industries in the Yukon for some time.

Since the estimations made in this chapter are often very tentative, speculation about the direct impact of the operating phase of the mining industry on the regional and national economies is very risky. However, it appears the mining industry's input expenditure has a direct impact on the regional economy of 30 to 40 per cent, assuming that three-quarters of labour income is initially spent in the Yukon.

The multiplier effect from this initial spending is very low for the economy has few sectors and most of the goods consumed in the Yukon are imported. Thus, transportation and the retail mark up is the only second stage income effect for a major proportion of income creation by the mining industry.

The remainder of the mining industry's input expenditures during the operating phase are primarily Canadian although direct spending on

non-Canadian inputs is now in excess of 15 per cent of total spending during the operating phase.[1]

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[1]As pointed out in the section on capital spending, machinery and equipment purchases by the Yukon mining industry have been allocated to Canadian sources, only 1 per cent going to the United States. If this represents the source of the distributor, then leakages from the Canadian economy would be substantially larger.

The Thompson, Manitoba study by Hedlin, Menzies and Associates Ltd. attributes only 4.4 per cent of purchases during the operating phase to non-Canadian sources but again, this is based on the source of the distributor, not the source of the producer. See Hedlin, Menzies and Associates Ltd., Thompson, Manitoba: An Historical Impact Analysis Of Resource Development, A report prepared for The International Nickel Company of Canada, Limited, (Toronto: 1970), p. 203.

CHAPTER SIX

POLICY IMPLICATIONS AND CONCLUSIONS

The purpose of this chapter is to provide some concluding observations on the Yukon mining industry as well as some suggestions for further study.

The Yukon mineral industry can be evaluated in terms of Canadian social and economic objectives. Two objectives that will be considered here are the goals of regional development[1] and maximization of economic benefits by an industry to the Canadian economy.

The mining industry has been an important force in contributing to the spatial development of Canada although its contribution to the long term self-sustaining development of a region may be limited. The Yukon mining industry is the leading sector in a region with few alternate employment opportunities; however, the changing nature of the industry is reducing its relative impact on the permanent population and the inducements to growing interdependence among the various sectors of the industry.

The most salient feature of the Yukon mining industry has been the increase in capital-intensity during the last decade and a concomitant increase in the skill requirements for mining personnel. The permanent population of the Yukon which has a large porportion of

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[1] The purpose of regional expansion in Canada is "to create new job opportunities in the slow growth areas of Canada and to help the people in these areas take advantage of the new opportunities." See Marchand, J. Honourable, "Planning for Regional Development," Community Planning Review, Vol. 19, No. 3, (Fall, 1969).

unskilled labour has therefore been excluded from active participation in the mining industry.

The increasing capital-intensity in the mining industry combined with a high rate of unemployment in the Yukon suggests that the elasticity of substitution of labour for capital is very low. The underlying technological requirements of the mining industry appear to be more important than relative factor prices in determining the proportions of labour and capital inputs. Thus, increased participation by the permanent labour force in the mining industry is dependent on upgrading its skills, rather than any change in the relative factor price of labour.

Another feature of the mining industry with regard to labour is the low female participation rate in the mining labour force which contributes to the high male/female ratio of 126 to 100. Mining towns such as Clinton Creek have an even greater male/female ratio imbalance.[1] The mining industry does not appear to be creating employment opportunities for the Yukon labour, except for the small highly skilled, mobile segment of the labour force.

A second major consideration is the contribution which the

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[1] The mining industry has a predominantly male work force with only 4.1 per cent of mining employees being female, compared to female participation of 22.5 per cent in the total Yukon labour force. As the mineral industry is projected by the Carr Report to increase its share of the Yukon labour force from 16.2 per cent in 1961 to 22.8 per cent in 1985, it seems likely that the ratio of women in the labour force will decline. Unless the trend to greater female employment in the Canadian economy is reversed, mining companies will have to continue to accept a high ratio of single employees with their typically higher rate of turnover, or compensate married employees for the loss of employment opportunities for females.

growth of the Yukon mining industry will make to development of the Yukon economy. The mining industry in many areas of the world often represents an enclave with little impact on the regional economy. Employing capital-intensive methods, a small and highly skilled labour force, and importing most input requirements, the industry may have few linkages with other sectors in the economy. Chapters Four and Five present a breakdown of inputs in the different phases of mining activity and the source by value of these inputs. The breakdown of input expenditures given in Chapter Four showed that backward linkages created by the mining industry have not only increased in value but they have increased their relative share of inputs since 1961.

However, it is also clear from Chapter Five that the impact of these backward linkages has been very limited. The erratic nature and lumpiness of investment during the development phases of mining activity results in most primary and interindustry input requirements being imported since it is not economic to develop industries in the Yukon catering to such an erratic demand.

Interindustry inputs from the Yukon for the operating phase of the mining industry are also limited because the higher costs of transportation from southern centres are not sufficient to overcome higher operating costs in the North. Even with scale economies possible from expansion of the mining industry, higher operating costs will continue to retard development of the other sectors.

Power and transportation are the two Yukon industries which have a good growth potential and are likely to achieve economies of scale as the mining industry expands. Power costs for the mining companies range

from 1.5 cents to 4 cents per KWH at present and can certainly be reduced if a power grid is developed.

Transportation facilities are already very efficient considering the size of the industry and a continued expansion of the mining industry may not reduce costs significantly because of the monopolistic nature of the service at present. However, the question of extending rail service from British Columbia is being seriously considered. This could reduce costs and increase the impact of the Yukon mining industry on the Canadian economy since 4 per cent of total mining expenditures were attributed to Alaska for transportation services in Chapter Five.

Primary inputs in the mining industry have decreased only slightly during the last decade but, as pointed out in the conclusions in Chapter Five, the relative labour/capital ratio has declined drastically with the advent of large scale open-pit mines. In 1969, the relative share of labour in total input expenditures at the underground operations at United Keno Hill Mines was 38.5 per cent whereas labour's relative share in the New Imperial open-pit mine was only 14.4 per cent.

The implications of increasing capital-intensity on the participation by the permanent Yukon labour force in the mining industry have already been discussed but the share of the industry's expenditures directed to labour also has an effect on the regional income multiplier. While calculations of the actual amount of labour income spent in the Yukon could not be made, the examination of labour and capital leakages in Chapter Five showed that the shift in the labour/capital ratio in the mining industry during the last decade has resulted in a relative, though not an absolute, decline in the regional impact of Yukon mining

expenditures.

In view of the limited impact of mining industry expenditures in the Yukon, the public policy of support for the mining industry as the leading sector must be re-examined.

Public policy appears to have changed within the last decade to "one in which the government had decided to abandon commercial feasibility as a guide to public resource developing activities. If this were done, public investment in infrastructure capital could be used to 'lead' private investment in directly productive activity. ..."[1]

Advocating this approach, the Carr Report suggests that public investment of 700 million dollars combined with private investment of 300 million by 1985 would result in expansion of the value of output from the mineral industry to 240 million dollars.[2]

The argument for promoting the development of the Yukon is carried even further by many others who want the federal government to reduce taxes and offer larger incentives in an effort to reduce northern costs to those prevailing in the southern regions of Canada.[3]

Extensive public investment in the Yukon and subsidization of the Yukon mining industry will increase its competitive position over other

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[1] Rea, K.J., op. cit., p. 356.

[2] Carr, D.W. and Associates Ltd., Vol. I, op. cit., p. 239.

[3] The demands for federal tax concessions and subsidies to lower operating costs in the North is carried to its extreme by the authors of the Carr Report who state that "it can be argued, after all, that the climate, distance and latitude are Canada's, since she claims the territory, and not the property or the responsibility of local residents." Ibid., p. 248.

Canadian regions. The Yukon and western Canadian mining industries are both oriented to the export markets in the Pacific Rim countries. While it can be argued that both regions are competing with other countries for these markets, it is reasonable to assume that extensive government encouragement of the Yukon mining industry would deflect some exploration funds from western Canada to the Yukon and reduce the level of mining production in western Canada.

Assuming that the decision to promote development of the Yukon by prior public investment is accepted, there is still some question about the direction and kind of public investment.

As the increasing capital-intensity and skill requirements of the Yukon mining industry restrict the active participation of the native labour force, consideration should be given to promotion of the second most viable Yukon industry, tourism. The tourist industry in the Yukon had a gross output of about 10 million dollars in 1970 and it has been growing rapidly during the last decade. While the gross value of tourism was only one-seventh of the gross value of mineral output in 1970, an examination of its impact on the Yukon economy might reveal that employment opportunities and income multiplier effects were not nearly as divergent as the gross value of output for each industry.

Linkages, both forward and backward, are typically low for transport, services and trade, the sectors which receive most of the tourist expenditures so that inducements, created by the tourist industry, for development of other sectors may be very limited.[1]

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[1] Hirschman, A.O., op. cit., p. 107.

However, the share of primary inputs in total tourist expenditures tends to be quite large and unskilled labour receives a significant proportion.

Of course, there are other disadvantages in relying on the tourist industry such as the shortness of the tourist season and the necessity for extensive investment in infrastructure and services. Nevertheless, public investment in infrastructure and services to promote the tourist industry would also benefit the mining industry.

The high rate of labour turnover and the higher level of operating costs for the Yukon mining industry are partially due to the limited infrastructure and social facilities in the Yukon.

A study of the Yukon tourist industry and its potential would, therefore, seem to be very beneficial in formulation of public policy since there is evidence to suggest that concentrating public investment on improving the Yukon's infrastructure for the benefit of both tourism and mining may be more useful than specific subsidies to the mining industry.[1]

The material contained in this study also has implications for specific public policy towards the Yukon mining industry. The development of large scale open-pit mines should enhance the stability of the industry but this appears to be at the expense of Canadian control of

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[1] An example of a specific mining subsidy is the Northern Mineral Exploration Assistance Programme which is a 9 million dollar federal programme granting up to 40 per cent of the cost of an approved exploration programme. For more details on federal programmes, see Abercombie, R.J., "An Analysis of Government Assistance in the North," Fifth National Northern Development Conference Proceedings, (Edmonton: Alberta North-West Chamber of Mines, 1971).

these resources, employment opportunities for much of the permanent population of the Yukon and a reduction in the relative impact per dollar of mining expenditures on the regional and national economies.

Capital demands will continue to increase as the industry becomes more capital-intensive. Unless Canadian capital sources can meet the increasing capital needs of the industry, it will require infusions of foreign equity and loan capital. The decline of effective Canadian ownership of the industry examined in Table 15 and the dominance of foreign capital in the large scale, capital-intensive mines implies that this is already the case.

This tendency not only creates a permanent leakage from the regional and national economy but it runs counter to the stated government policy of increasing Canadian ownership of the mining industry.[1] As the large scale mines in the Yukon appear to enjoy a good profit potential, regulations on ownership control and employment policies may promote Canadian objectives without preventing the development of large scale mines.[2] The necessity for negotiation, between the government and each company wishing to open a mine, about the level of public

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[1]See, for example, the speech made by the Honourable J.J. Greene, Minister of Energy, Mines and Resources. Greene, J.J., "Concerning the Budget Speech," House of Commons Debates, (Ottawa: Queen's Printer, June 23, 1971).

[2]The federal government has already taken some action on these policy issues. Bill C-187, now being considered contains a section placing restrictions on foreign ownership in the mining industry. See The House of Commons of Canada, Bill C-187: An Act Respecting Minerals in the Yukon Territory, (Ottawa: Queen's Printer, 1970), Part V, Leases 73(2).

investment in roads and other facilities allows regulations to be adjusted to individual conditions.

Smaller mines have a relatively greater impact on the regional economy, but they contribute to the instability of the Yukon economy and a loss of public investment unless they operate for a reasonable length of time.[1] It would appear to be in the public interest for some standards to be set about expected length of operation and the grade of ore to be extracted. The practise of 'high grading' examined in Chapter Three results in only a portion of the economically feasible ore content being removed. The development of a more interdependent economy in the Yukon requires stability and some permanence in mining activity and public policy should encourage this.[2]

The significant reduction in the relative impact per dollar of mining expenditures outlined in Chapter Five suggests that public policy should be just as concerned with maximizing the impact of mining activities on the regional and national economies as with maximizing the gross

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[1] Two recent examples of mines which received public investment in the form of roads, etc. were Arctic Gold and Silver Mining Company and Mount Nansen mines. Both ceased operations within a year and thus contributed very little to employment or public revenue.

[2] "In a country whose standard of living is higher than ours with almost full employment, I know of some mineral deposits whose life is over 25 years where Canadian practise and philosophy would have depleted such mines in five years," a comment made by the Deputy Minister of the Department of Energy, Mines and Resources, Drolet, M. Jean-Paul, "A Private Campaign on Mining Policy," Financial Times of Canada, November 4, 1968.

value of mineral production.[1]

This final chapter has suggested a number of specific objectives that might be incorporated in public policy towards the Yukon mining industry. These policy changes, however, would require further research on the industry and the Yukon economy in order to determine more accurate estimates of the effect of any policy change. However, as this study emphasizes, the paucity of information on GNP data as well as on the costs and proportions of inputs used by the mining industry inhibits research and reduces its reliability.

Further research on the Yukon mineral industry will also have to take into consideration the significant differences within the mining industry. The diversity in input usage and the corresponding differences in effects on the regional economy implies that future models of the Yukon mining industry, to be really useful for predictive and policy purposes, should be reasonably disaggregated.

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[1] There are a number of externalities which are extremely important but which have not been considered in this study. There is increasing public concern about pollution created by industry and about preservation of the fragile ecology in the North. These are other areas for research and government regulation.

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APPENDIX A

Cost functions are presented here for the three types of mining operations outlined in Chapter Four. While these cost functions based on Canadian mines give some indication of the different levels of operating costs, they are not directly useful for this study. As the functions are regressed on only one variable, tonnage of reserves, they are most useful in determining the profitability of ore deposits.

The authors[1] collected data on capital costs, operating costs, tonnage of reserves and productive life of Canadian mines and applied regression analysis to determine the parameters of the relationships between these variables.

The authors point out clearly that "even for this simplified approach to the definition of costs, this study suffered from the scarcity of industry cost data, ... for some of the commodities the observations were very few."[2]

1. The most appropriate aggregate underground operating cost function was:

$$OP = \underset{(8.34430985)}{39.08400213} - \underset{(1.36873260)}{5.12879584} \log (T)$$

where

OP = regression estimate of operating costs

T = tons of reserves

$R^2 = .452$

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[1] Harris, D.P., Freyman, A.J. and Barry, G.S., op. cit.

[2] Ibid., p. 17.

F = 14.04

N = number of observations = 19

A stochastic term was added to this regression

$$OC = OP + 2.98079\ Z$$

where

OC = final version of operating cost

Z = standard normal deviate obtained from random sampling on a normal distribution with mean of zero and standard deviation of one.

2.98079 = standard error of the regression estimate

For $OC < 4.0$, $OC = 4.0$

2. The aggregate open-pit operating cost function could not be developed by regression techniques as the number of observations was very small. Monte Carlo methods were used with the mean and standard deviation as the parameters of a normal curve.

$OC = 3.4 + 1.9Z$

Z = standard normal deviate

3. The asbestos operating cost function was based on only seven operations.

$$OP = \underset{(59.27717988)}{224.17836109} + \underset{(.91730915)}{3.29627136}\ [\log(T)]^2 - \underset{(14.77752153)}{54.0981637}\ \log(T)$$

$OC = OP + .36119Z$

$R^2 = .850$

N = 7

F ratio = 11.39

For $OC < 2.0$, $OC = 2.0$

APPENDIX B

ILLUSTRATIVE YUKON TRANSACTIONS TABLE, 1966[1]

	Mining	Forestry	Other Primary	Manufac-turing	Construc-tion	Trptn., Stge. &	Electric Power	Services	Final Output Domestic	Final Output Export	Total Output
	(Producers' prices in thousands of dollars)										
Mining	50	---	---	---	20	---	---	30	---	10,000	10,100
Forestry	100	---	---	---	330	---	45	---	125	---	600
Other Primary	---	---	1	---	---	---	---	---	62	50	113
Manufacturing	---	---	---	55	100	45	---	100	300	---	600
Construction	105	10	5	10	20	1,250	180	1,720	15,900	---	19,200
Trptn., Stge. and Trade	800	50	---	---	4,600	4,700	---	1,400	6,700	7,250	25,500
Electric Power	690	20	---	70	70	90	370	230	760	---	2,300
Services	400	---	---	---	550	700	---	950	11,000	---	13,600
Imports	955	70	31	250	6,510	715	405	370			
Wages and Salaries	4,100	200	10	150	5,200	10,500	500	6,300			
Other Primary Inputs	2,900	250	66	65	1,800	7,500	800	2,500			
Total Primary Inputs	7,000	450	76	215	7,000	18,000	1,300	8,800			
Total Input	10,100	600	113	600	19,200	25,500	2,300	13,600			

Source: A Model Simulation attempted by Carr, D.W. and Associates Ltd., Vol. III, op. cit., Appendix B.

Notes: [1]For extensive footnoting on the estimations used, see pp. 73-75 in the source.